BELL & HOWELL SCHOOLS

ASSEMBLY MANUAL 9570

Oscilloscope

595-1855-02

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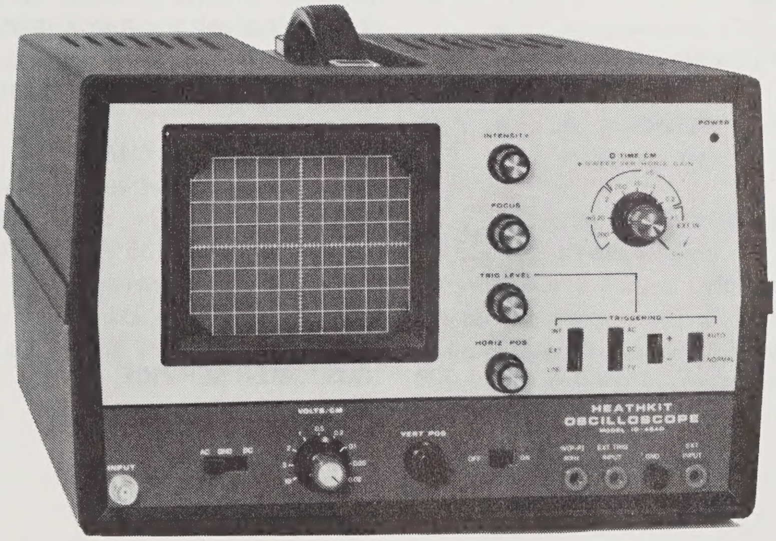
Assembly
and
Operation
# of the
HEATHKIT

5 MHz PORTABLE OSCILLOSCOPE

MODEL IO-4540



HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit Model IO-4540 5 MHz Portable Oscilloscope is a compact, versatile, easy-to-build, electronic instrument that you can use to study the waveforms in electronic circuits. You can also use it to measure frequency, and AC or DC voltages. The DC to 5 MHz bandwidth and the excellent input sensitivity of the vertical amplifier allow you to use this Oscilloscope for nearly all types of waveform display applications. The triggered horizontal sweep circuit and the many other outstanding features provide accuracy and capabilities that are usually found only in higher priced oscilloscopes.

Among the many other features this Oscilloscope offers are:

- A special TV position on the trigger selector. This allows low frequencies to pass while rejecting high frequencies, thus making it easier to trigger on the vertical frequency of a TV set.
- Power transformers that are swivel-mounted so they can be tuned for minimum hum on the trace.
- A 10 to 1 attenuation circuit that can be used for horizontal input signals.
- An accurately calibrated vertical attenuator with a variable control.
- A calibrated time base (seven time base selections, variable within each selection).
- Regulated vertical, horizontal, and sweep circuit power supplies.

Refer to the "Kit Builders Guide" for additional information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

UNPACKING

Your Oscilloscope is packed in a large shipping carton which contains two other boxes, some smaller packages, and loose parts. One of the boxes inside the large carton contains the CRT (Cathode Ray Tube). The other box, marked "Packs 1-4," is divided into sections called packs. The smaller packages and loose parts in the large shipping carton are part of the "Final Pack" (Pack 5).

In each Parts List, you will be instructed to remove the parts from one of the packs. You may also be instructed to remove some parts from the Final Pack.

DO NOT unpack any parts until you are instructed to do so. DO NOT remove the CRT from its box until you are instructed to do so.

ASSEMBLY NOTES

A separate "Illustration Booklet" contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. The illustrations are arranged in Pictorial number sequence. Place the Booklet in a convenient location and keep it with the Assembly Manual.

Each circuit part in this kit has its own component number (R2, C4, etc.). Use these numbers when you want to positively identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

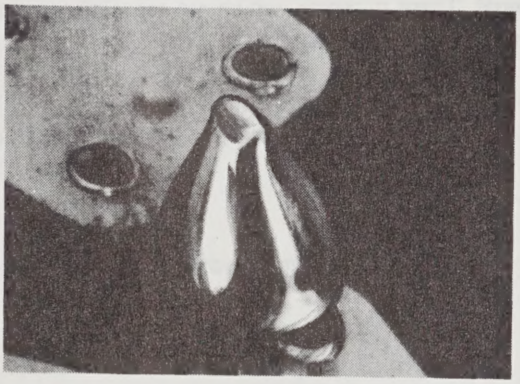
- In the Parts Lists,
- At the beginning of each step where a component is installed,
- In some illustrations,
- In the Schematic,
- In the sections at the rear of the Manual.

SOLDERING INSTRUCTIONS

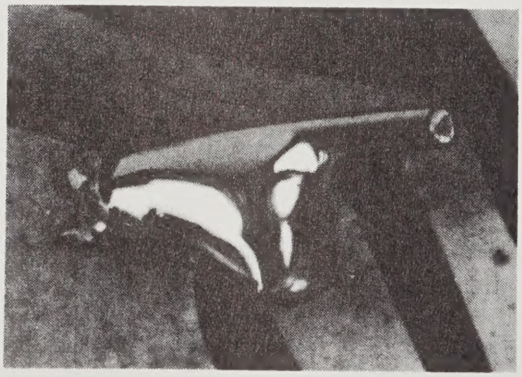
Poor soldering accounts for about 90% of all kit building problems. The following photographs show examples of the types of bad solder connections that are the most common cause of trouble. If you locate any of these bad solder connections in your kit, correct them as instructed. Study this section carefully before you begin to assemble your kit.

SOLDER CONNECTIONS TO WATCH OUT FOR

The following photographs show examples of the types of bad solder connections that are the most common cause of trouble. If you locate any of these bad solder connections in your kit, correct them as instructed.



In this case, the solder was applied to the lead but did not flow onto the foil. To correct, reheat the connection.



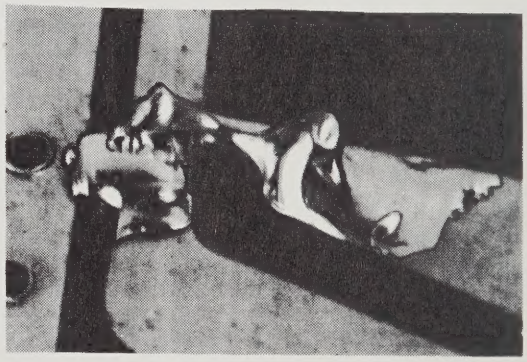
Here, solder has flowed along a lead and bridged to another foil. To correct, hold the circuit board above the soldering iron and reheat the solder. As the solder melts, it will flow down the iron. Then cut off the excess lead length. PROTECT YOUR EYES.

Before you start to assemble this kit, read the wiring, soldering, and step-by-step assembly information in the "Kit Builders Guide."

Resistors will be called out by their value and color code in Ω (ohms), kΩ, or MΩ. K = 1000, M = 1,000,000. Use 1/2-watt resistors unless the step directs otherwise.

Capacitors are called out by their type (disc, Mylar*, electrolytic, etc.) and capacitance (μF or pF).

To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

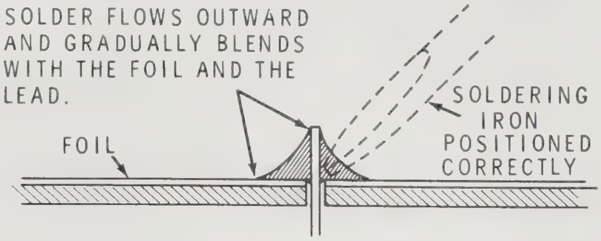


Here, hot solder has been dropped onto the foil and the solder connected or bridged (or crossed) three foils. To correct, hold the circuit board above the soldering iron and reheat the solder. As the solder melts, it will flow down the iron. PROTECT YOUR EYES.

NOTE: Solder that bridges two connections on the SAME FOIL is alright and should not be corrected.

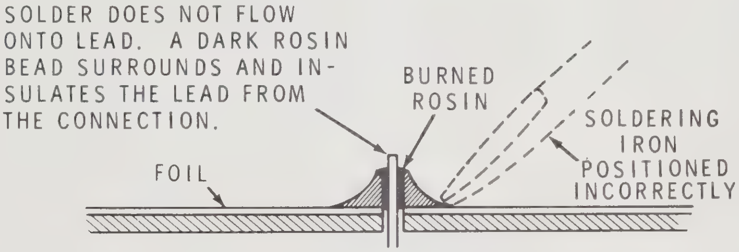
*DuPont Registered Trademark.

A GOOD SOLDER CONNECTION

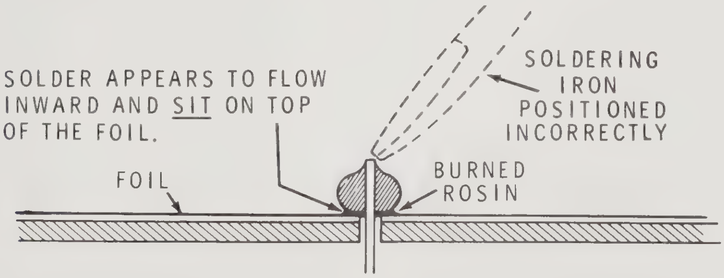

SOLDER FLOWS OUTWARD AND GRADUALLY BLENDS WITH THE FOIL AND THE LEAD.
FOIL
SOLDERING IRON POSITIONED CORRECTLY

When both the lead and the circuit board foil are heated at the same time, the solder will flow onto the lead and the foil evenly. The solder will then make a good electrical connection between the lead and the foil.

BAD SOLDER CONNECTIONS


SOLDER DOES NOT FLOW ONTO LEAD. A DARK ROSIN BEAD SURROUNDS AND INSULATES THE LEAD FROM THE CONNECTION.
BURNED ROSIN
FOIL
SOLDERING IRON POSITIONED INCORRECTLY

When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. Reheat the connection and, if necessary, apply a small amount of additional solder to obtain a connection as shown under "A Good Solder Connection."


SOLDER APPEARS TO FLOW INWARD AND SIT ON TOP OF THE FOIL.
FOIL
SOLDERING IRON POSITIONED INCORRECTLY
BURNED ROSIN

When the foil is not heated sufficiently, the solder will blob on the circuit board as shown above. Reheat the connection and, if necessary, apply a small amount of additional solder to obtain a connection as shown under "A Good Solder Connection."

VERTICAL AMPLIFIER CIRCUIT BOARD

PARTS LIST

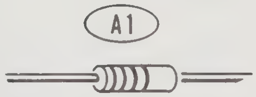
Unpack Pack #1 (refer to the "Pack Index Sheet") and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packed in an individual envelope with a part number on it should not be removed from the envelope until it is called for in a step. Do not throw away any packing material until all parts are accounted for.

RESISTORS

1/2-Watt

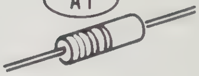
NOTE: All resistors have a 5% tolerance (gold fourth band) unless they are listed otherwise.

KEY No.		QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
A1	(X)	2	56 Ω (green-blue-black)	1-83	R112, R113
A1	(X)	2	100 Ω (brown-black-brown)	1-123	R116, R118
A1	(X)	2	330 Ω (orange-orange-brown)	1-151	R122, R123
A1	(X)	3	470 Ω (yellow-violet-brown)	1-157	R107, R114, R115
A1	(X)	2	1000 Ω (brown-black-red)	1-172	R117, R119

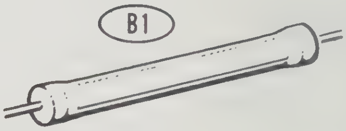


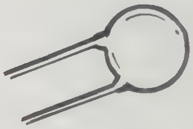
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Resistor (cont'd.)				
A1 ☒	2	2700 Ω (red-violet-red)	1-158	R124, R129
A1 ☒	4	4700 Ω (yellow-violet-red)	1-43	R105, R106, R109, R121
A1 ☒	1	10 kΩ (brown-black-orange)	1-105	R125
A1 ☒	1	12 kΩ (brown-red-orange)	1-109	R104
A1 ☒	1	100 kΩ (brown-black-yellow)	1-104	R101
Others				
B1 ☒	2	5600 Ω (5.6 k), 10%, 4-watt.	5-1-4	R126, R127
CAPACITORS				
C1 ☒	1	20 pF disc	21-5	C106
C1 ☒	1	75 pF disc	21-86	C102
C1 ☒	1	180 pF disc	21-162	C105
C1 ☒	1	680 pF disc	21-171	C104
C1 ☒	2	.01 µF disc	21-16	C101, C109
C2 ☒	2	10 µF electrolytic	25-54	C103, C108
C3 ☒	1	80-400 pF trimmer	31-77	C107
CONTROLS				
D1 ☒	2	1000 Ω (1 k)	10-936	R108, R111
D1 ☒	2	2000 Ω (2 k)	10-398	R102, R128
D1 ☒	1	10 kΩ	10-386	R103
DIODES				
E1 ☒	1	1N191 diode (brown-white-brown)	56-26	D104
E1 ☒	1	1N4149 diode	56-56	D103

A1

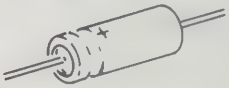


B1



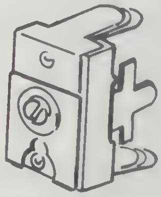


C1

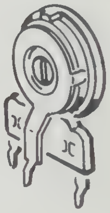


C2

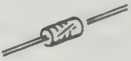
C3



D1



E1



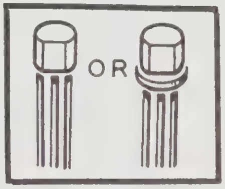
TRANSISTORS

NOTE: Transistors are marked for identification in one of the following ways:

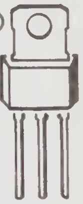
1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
F1 (X)	2	L842	417-83	Q105, Q106
F1 (X)	2	X29A829	417-201	Q107, Q108
F1 (X)	2	EL131	417-241	Q101, Q103
F1 (X)	5	MPSA20	417-801	Q102, Q104, Q111, ZD101, ZD102
F2 (X)	2	MPSU10	417-834	Q109, Q110.

F1



F2



PARTS FROM THE FINAL PACK

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
(X)	1	Vertical amplifier circuit board	85-1533-5	
(X)	30"	Bare wire	340-8	
(X)	6'	Shielded cable	343-15	
(X)	2'	Twin lead	347-2	
( )	1	Kit Builders Guide	597-308	
( )	1	Parts Order Form	597-260	
( )	1	Assembly Manual (See front cover for part number.)		
		Solder (Additional 3' rolls of solder, #331-6, can be ordered for 25 cents each.)		

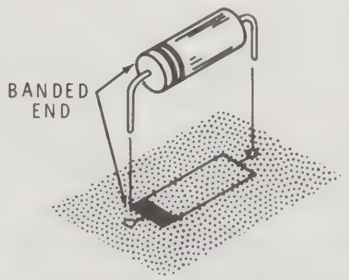
NOTE: The prices shown on the separate "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

START

- ☒ Locate the vertical amplifier circuit board (#85-1533-5) and position it as shown. Then complete the following steps.
- ☒ R124: 2700 Ω (red-violet-red).
- ☒ R123: 330 Ω (orange-orange-brown).
- ☒ R119: 1000 Ω (brown-black-red).
- ☒ R118: 100 Ω (brown-black-brown).
- ☒ R115: 470 Ω (yellow-violet-brown).
- ☒ R113: 56 Ω (green-blue-black).
- ☒ Solder the leads to the foil and cut off the excess lead lengths.
- ☒ R109: 4700 Ω (yellow-violet-red).
- ☒ R121: 4700 Ω (yellow-violet-red).
- ☒ R105: 4700 Ω (yellow-violet-red).
- ☒ R107: 470 Ω (yellow-violet-brown). NOTE: Do not use a 4700 Ω resistor here by mistake.

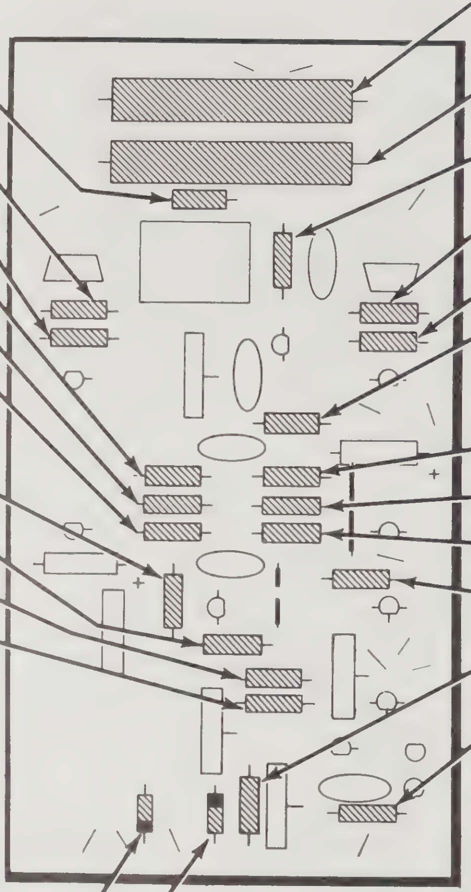
NOTE: Whenever you install a diode, as in the next step, be sure to position the banded end as shown on the circuit board.



- ☒ D103: IN4149 diode (#56-56).
- ☒ D104: IN191 diode (brown-white-brown, #56-26).
- ☒ Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

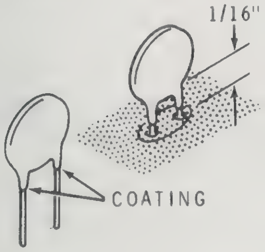
- ☒ R127: 5600 Ω (5.6k), 4-watt resistor. Space this resistor 1/8" off the circuit board.
- ☒ R126: 5600 Ω (5.6k), 4-watt resistor. Space this resistor 1/8" off the circuit board.
- ☒ R125: 10 kΩ (brown-black-orange).
- ☒ R122: 330 Ω (orange-orange-brown).
- ☒ R117: 1000 Ω (brown-black-red).
- ☒ R129: 2700 Ω (red-violet-red).
- ☒ Solder the leads to the foil and cut off the excess lead lengths.
- ☒ R116: 100 Ω (brown-black-brown).
- ☒ R114: 470 Ω (yellow-violet-brown).
- ☒ R112: 56 Ω (green-blue-black).
- ☒ R104: 12 kΩ (brown-red-orange).
- ☒ R106: 4700 Ω (yellow-violet-red).
- ☒ R101: 100 kΩ (brown-black-yellow).
- ☒ Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-1

START

NOTE: A coating on disc capacitor leads next to the capacitor body will sometimes make soldering difficult. When you install one of these capacitors, position it 1/16" off the circuit board. This will prevent the coating from protruding through the circuit board.

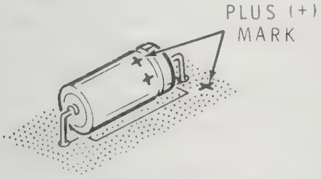


(X) C106: 20 pF disc.

(X) C109: .01 µF disc.

(X) C105: 180 pF disc.

NOTE: When you install an electrolytic capacitor, always position the plus (+) marked end of the capacitor toward the plus mark on the circuit board.



(X) C103: 10 µF electrolytic.

(X) C104: 680 pF disc.

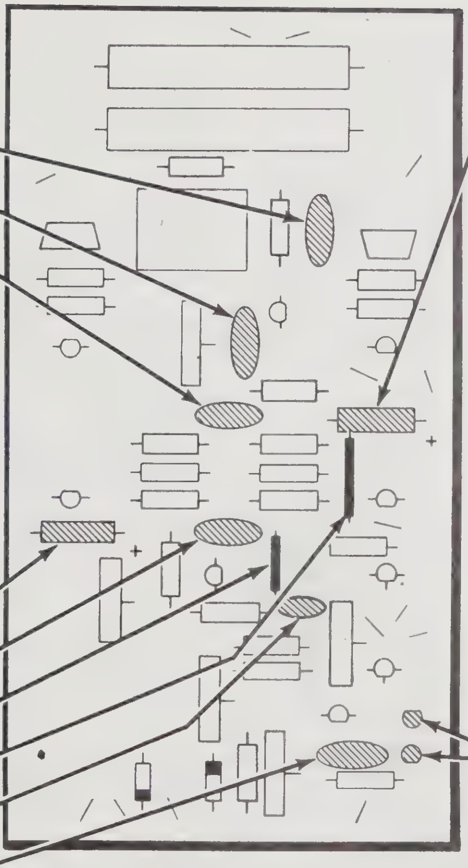
(X) 3/4" bare wire.

(X) 1" bare wire.

(X) C102: 75 pF disc.

(X) C101: .01 µF disc.

(X) Solder the leads to the foil and cut off the excess lead lengths.

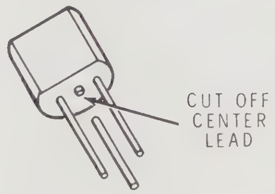


PICTORIAL 1-2

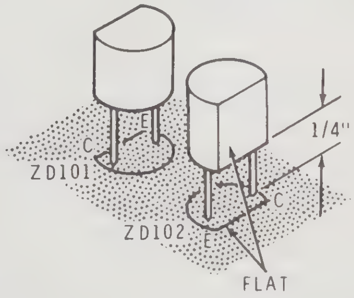
CONTINUE

(X) C108: 10 µF electrolytic. Be sure to position the plus marked end as shown on the circuit board.

(X) Locate two MPSA20 transistors (#417-801) and cut the center lead from both transistors.



(X) Install one transistor at ZD101 and the other transistor at ZD102. Make sure the flat of each transistor is positioned over the outline of the flat on the circuit board.

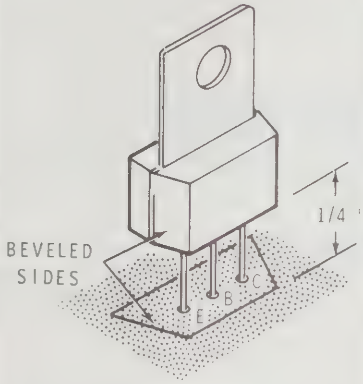


(X) Solder the leads to the foil and cut off the excess lead lengths.

0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

START

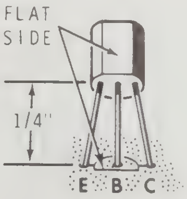
NOTE: Install each of the next two transistors in the following manner. First, position the transistor over the outline on the circuit board so the beveled side of the transistor matches the beveled side of the outline. Then insert the leads into their correct E, B, and C holes. Solder the leads to the foil and cut off the excess lead lengths.



( ) Q109: MPSU10 transistor (#417-834).

( ) Q110: MPSU10 transistor (#417-834). Note that this transistor is positioned in the opposite direction from Q109.

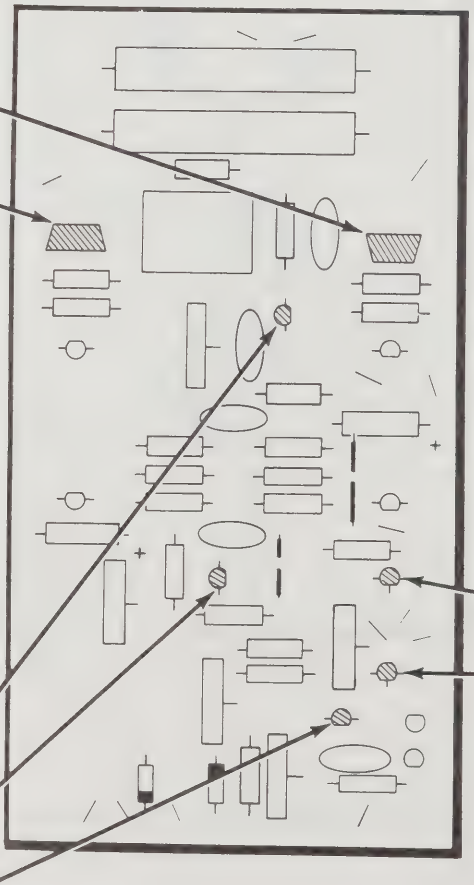
NOTE: When you install the following transistors, be sure to position each transistor with its flat over the outline of the flat on the circuit board. Then insert the leads into their correct E, B, and C holes. Solder the leads to the foil and cut off the excess lead lengths.



( ) Q111: MPSA20 transistor (#417-801).

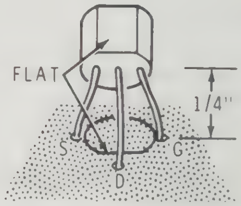
( ) Q104: MPSA20 transistor (#417-801).

( ) Q102: MPSA20 transistor (#417-801).



CONTINUE

NOTE: When you install the following transistors, be sure to position each transistor with its flat over the outline of the flat on the circuit board. Then insert the leads into their correct S, D, and G holes. Solder the leads to the foil and cut off the excess lead lengths.



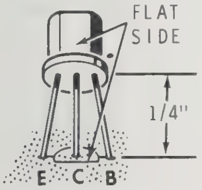
(X) Q103: EL131 transistor (#417-241).

( ) Q101: EL131 transistor (#417-241).

PICTORIAL 1-3

START

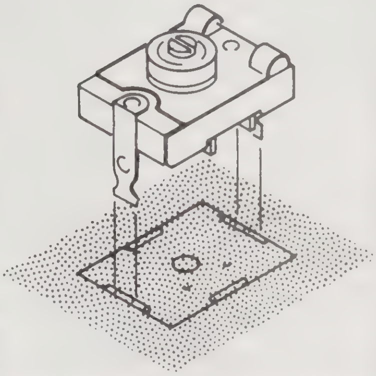
NOTE: When you install the following transistors, be sure to position each transistor with its flat over the outline of the flat on the circuit board. Then insert the leads into their correct E, C, and B holes. Solder the leads to the foil and cut off the excess lead lengths.



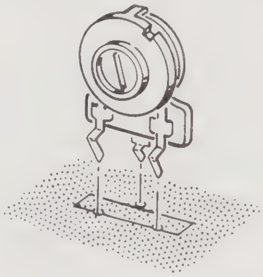
- (X) Q107: X29A829 transistor (#417-201).
- (X) Q108: X29A829 transistor (#417-201).
- (X) Q106: L842 transistor (#417-83).
- (X) Q105: L842 transistor (#417-83).

CONTINUE

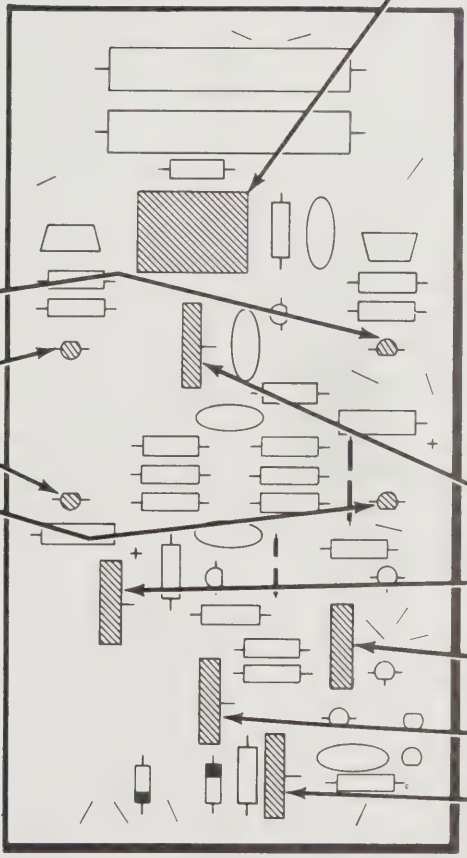
- (X) C107: 80-400 pF trimmer (#31-77). Solder only the two lugs that have foil around them. Note that the lugs are made up of more than one tab. Make sure all of the tabs become soldered.



NOTE: In the following steps be sure that you install the correct value control in each position. Solder the lugs of each control to the foil as it is installed.



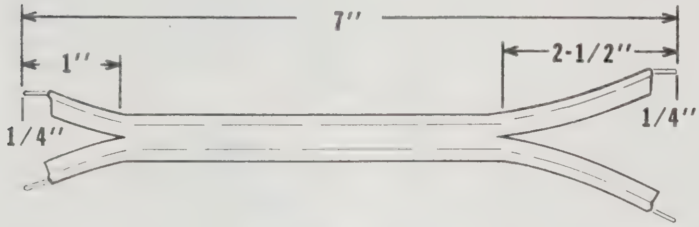
- (X) R128: 2000 Ω (2k) control (#10-398).
- (X) R111: 1000 Ω (1k) control (#10-936).
- (X) R102: 2000 Ω (2k) control (#10-398).
- (X) R108: 1000 Ω (1k) control (#10-936).
- (X) R103: 10 kΩ control (#10-386).



PICTORIAL 1-4

Refer to Pictorial 1-5 for the following steps.

(X) Prepare a 7" twin lead as follows, as shown in Detail 1-5A.



Detail 1-5A

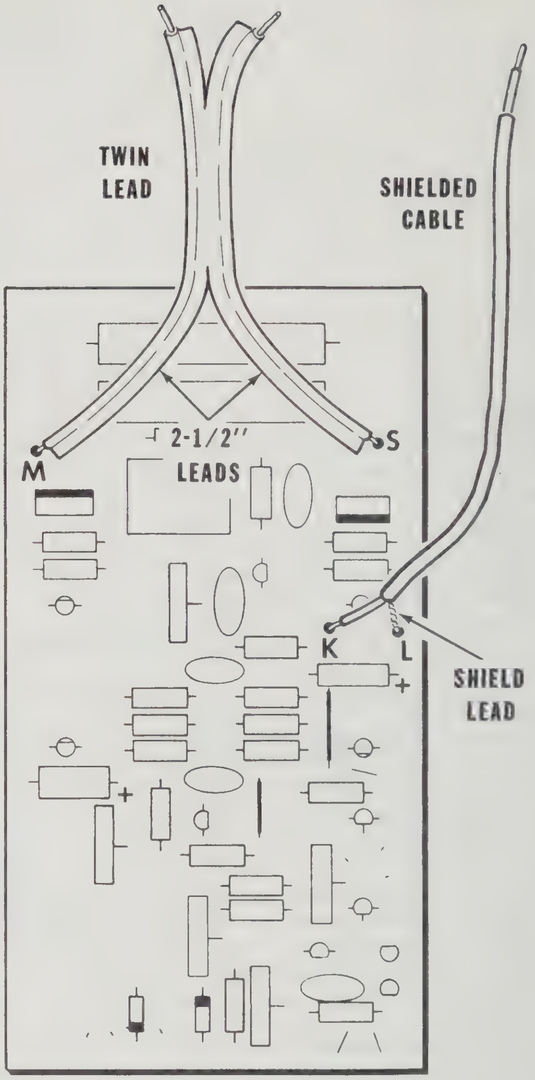
1. Cut the ends of the twin lead down the middle to form two leads at either end.
2. Remove 1/4" of insulation from each lead. Then twist together the fine wire strands at the end of each lead and apply just enough solder to hold them in place.

(X) Connect the 2-1/2" leads of the twin lead to holes S and M on the circuit board. Solder the leads to the foil.

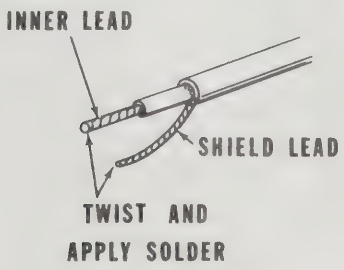
NOTE: Each time you prepare shielded cable, look at the inner lead and shield lead to see if they are pretinned (have solder already applied). If the inner lead and shield lead are not pretinned, twist together the fine wire strands of each lead, as shown in Detail 1-5C. Then apply a small amount of solder to hold the strands in place.

(X) Refer to Detail 1-5B and prepare a 15" shielded cable.

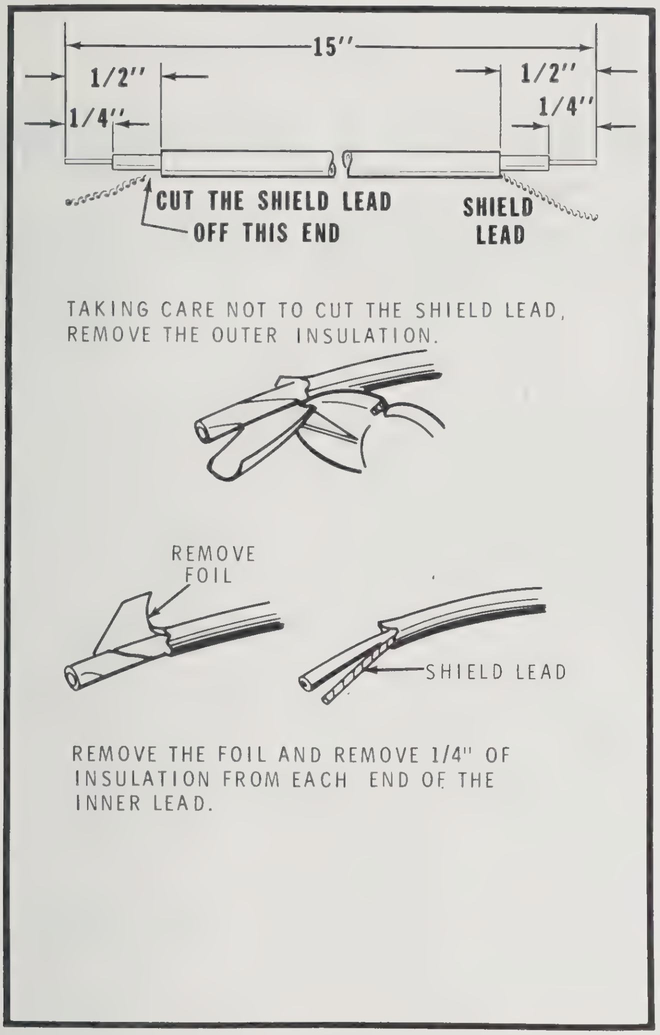
(X) Connect the inner lead of the shielded cable to hole K and the shield lead to hole L on the circuit board. Solder the leads to the foil.



PICTORIAL 1-5



Detail 1-5C



TAKING CARE NOT TO CUT THE SHIELD LEAD, REMOVE THE OUTER INSULATION.

REMOVE THE FOIL AND REMOVE 1/4" OF INSULATION FROM EACH END OF THE INNER LEAD.

Detail 1-5B

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

(✓) Unsoldered connections.

(✓) "Cold" solder connections.

(✓) Solder bridges between foil patterns.

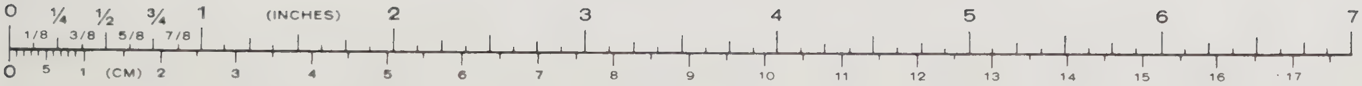
(✓) Protruding leads which could touch together.

(✓) Transistors for the proper type and installation.

(✓) Electrolytic capacitors for the correct position of the plus (+) end.

(✓) Diodes for the correct position of the banded end.

(✓) Set the circuit board aside.

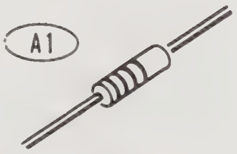

0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

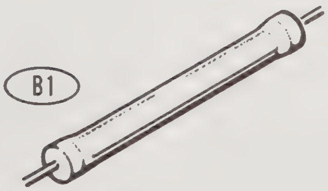
HORIZONTAL AMPLIFIER CIRCUIT BOARD

Unpack Pack #2 (refer to the "Pack Index Sheet") and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packed in an individual envelope with a part number on it should not be removed from the envelope until it is called for in a step. Do not throw away any packing material until all parts are accounted for.

PARTS LIST

KEY No.		QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
	RESISTORS				
	1/2-Watt				
	NOTE: All resistors have a 5% tolerance (gold fourth band) unless they are listed otherwise.				
A1	(X)	2	100 Ω (brown-black-brown)	1-123	R211, R212
A1	(X)	1	220 Ω (red-red-brown)	1-147	R207
A1	(X)	2	510 Ω (green-brown-brown)	1-63	R216, R217
A1	(X)	3	1000 Ω (brown-black-red)	1-172	R213, R214, R218
A1	(X)	4	4700 Ω (yellow-violet-red)	1-43	R205, R206, R209, R215
A1	(X)	1	12 kΩ (brown-red-orange)	1-109	R204
A1	(X)	1	100 kΩ (brown-black-yellow)	1-104	R201
	Others				
B1	(X)	2	10 kΩ, 10%, 7-watt	5-3-7	R219, R221

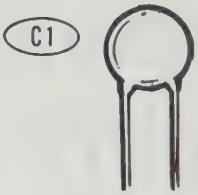


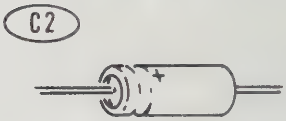


KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

CAPACITORS

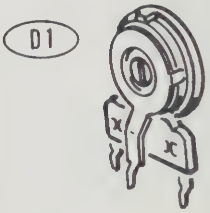
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
C1 (X)	1	220 pF disc	21-22	C204
C1 (X)	1	470 pF disc	21-56	C203
C1 (X)	1	.01 μF disc	21-16	C201
C2 (X)	1	10 μF electrolytic	25-54	C202





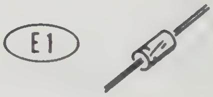
CONTROLS

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
D1 (X)	1	500 Ω	10-918	R208
D1 (X)	1	10 kΩ	10-386	R203
D1 (X)	1	20 kΩ	10-390	R202



DIODE

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
E1 (X)	1	1N4149 diode	56-56	D204
(X)	1	GESTB 620 diode	56-61	D203

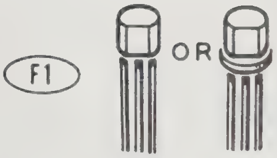


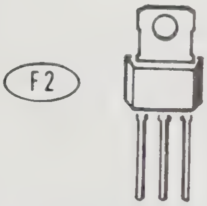
TRANSISTORS

NOTE: Transistors are marked for identification in one of the following ways:

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Transistors (cont'd.)				
F1 (X)	2	L842	417-83	Q205, Q206
F1 (X)	2	EL131	417-241	Q201, Q203
F1 (X)	4	MPSA20	417-801	ZD201, ZD202, Q202, Q204
F2 (X)	2	MPSU10	417-834	Q207, Q208



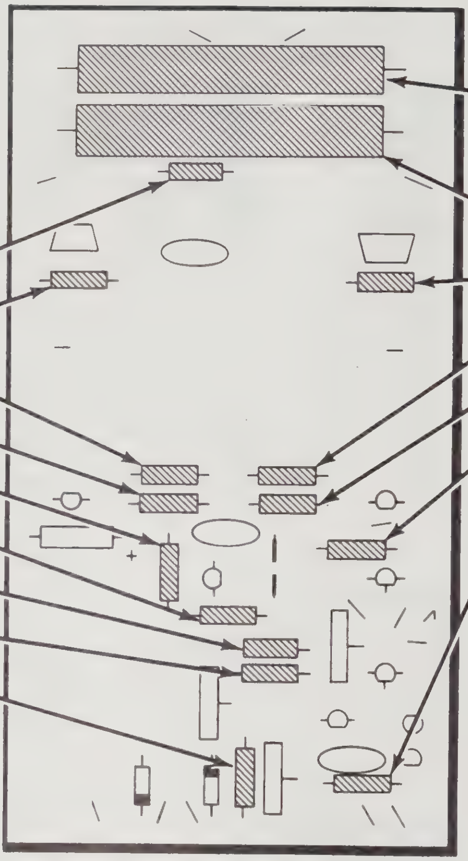


PARTS FROM THE FINAL PACK

(X)	1	Horizontal amplifier circuit board	85-1533-4

NOTE: The prices shown on the separate "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY



PICTORIAL 2-1

START

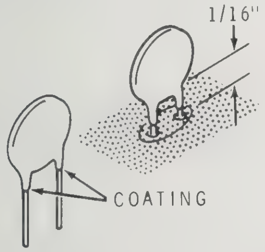
- (X) Locate the horizontal amplifier circuit board (#85-1553-4) and position it as shown. Then complete the following steps.
- (X) R218: 1000 Ω (brown-black-red).
- (X) R217: 510 Ω (green-brown-brown).
- (X) R214: 1000 Ω (brown-black-red).
- (X) R212: 100 Ω (brown-black-brown).
- (X) R209: 4700 Ω (yellow-violet-red).
- (X) R215: 4700 Ω (yellow-violet-red).
- (X) R205: 4700 Ω (yellow-violet-red).
- (X) R207:220 Ω (red-red-brown).
- (X) R206: 4700 Ω (yellow-violet-red).
- (/) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

- (X) R221: 10 kΩ, 10%, 7-watt film resistor. Space this resistor 1/8" off the circuit board.
- (X) R219: 10 kΩ, 10%, 7-watt film resistor. Space this resistor 1/8" off the circuit board.
- (X) R216: 510 Ω (green-brown-brown).
- (X) R213: 1000 Ω (brown-black-red).
- (X) R211: 100 Ω (brown-black-brown).
- (X) R204: 12 kΩ (brown-red-orange).
- (X) R201: 100 kΩ (brown-black-yellow).
- (/) Solder the leads to the foil and cut off the excess lead lengths.

START

NOTE: A coating on disc capacitor leads next to the capacitor body will sometimes make soldering difficult. When you install one of these capacitors, position it 1/16" off the circuit board. This will prevent the coating from protruding through the circuit board.



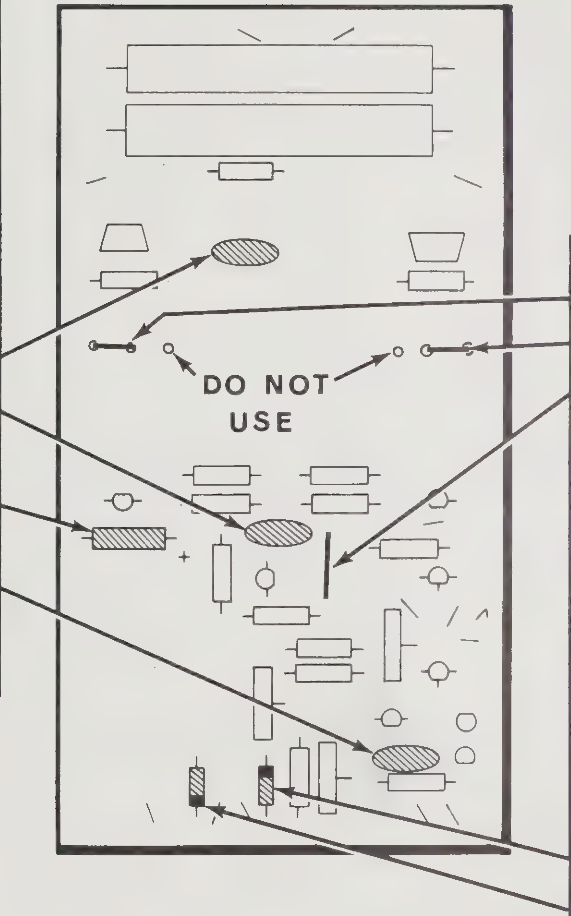
( ) C204: 220 pF disc.

(X) C203: 470 pF disc.

(X) C202: 10 μF electrolytic. Be sure to position the plus (+) marked end of the capacitor toward the plus (+) mark on the circuit board.

(X) C201: .01 μF disc.

(X) Solder the leads to the foil and cut off the excess lead lengths.



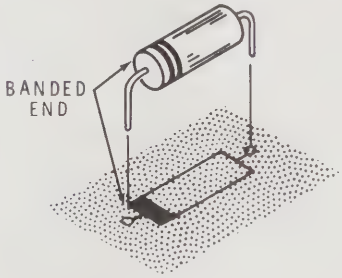
CONTINUE

(X) 1/2" bare wire.

( ) 1/2" bare wire.

( ) 1" bare wire.

NOTE: When you install the next two diodes, be sure to position the banded end of each diode as shown on the circuit board.

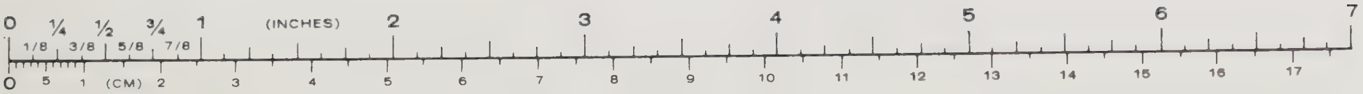


(X) D204: 1N4149 diode (#56-56).

(X) D203: GESTB620 diode (#56-61).

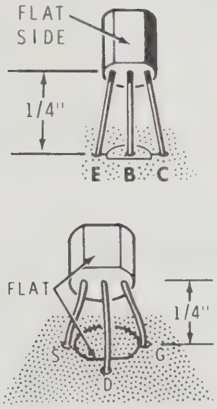
(X) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-2



START

NOTE: When you install the following transistors, be sure to position each transistor with its flat over the outline of the flat on the circuit board. Insert the leads into their correct E, B, and C or S, D, and G holes. Solder the leads to the foil and cut off the excess lead lengths.

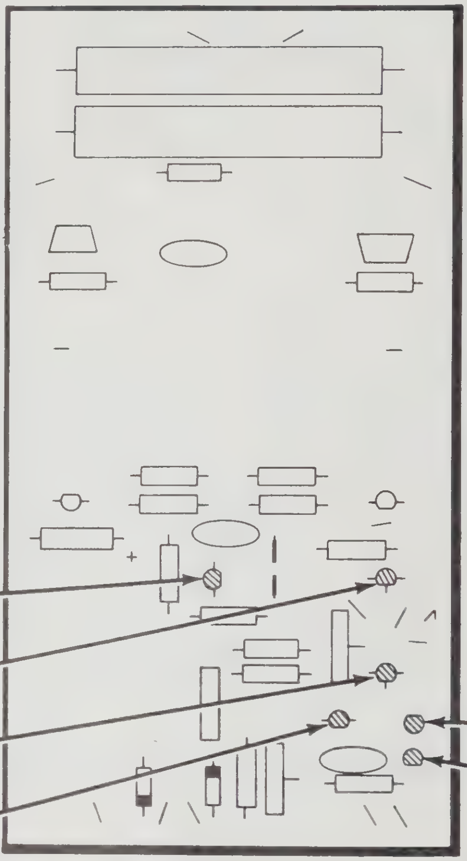


(✓) Q204: MPSA20 transistor (#417-801).

(✓) Q203: EL131 transistor (#417-241).

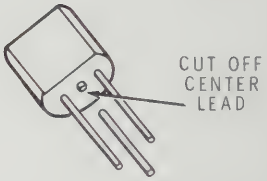
(✓) Q201: EL131 transistor (#417-241).

(✓) Q202: MPSA20 transistor (#417-801).

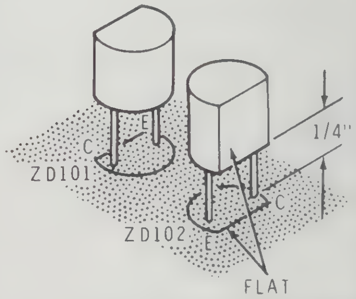


CONTINUE

(✓) Locate two MPSA20 transistors (#417-801) and cut off the center leads.



Install the two prepared transistors as shown.



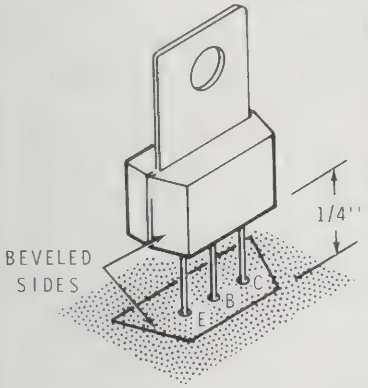
(✓) ZD201.

(✓) ZD202.

PICTORIAL 2-3

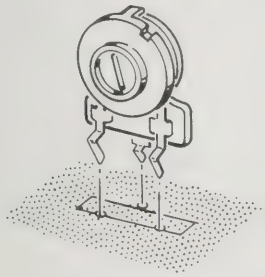
START

NOTE: Install each of the next two transistors in the following manner. First, position the transistors over the outline on the circuit board so the beveled side of the transistor matches the beveled side of the outline. Then insert the leads into their correct E, B, and C holes. Solder the leads to the foil and cut off the excess lead lengths.

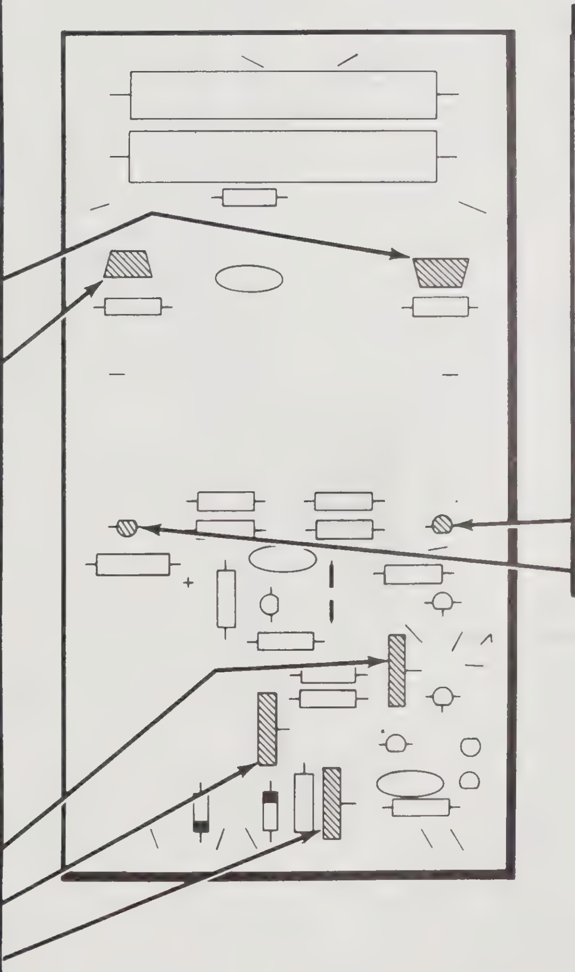


- (X) Q207: MPSU10 transistor (#417-834).
- (X) Q208: MPSU10 transistor (#417-834).

NOTE: When you install the next three controls, insert the control lugs through the circuit board and solder them to the foil.

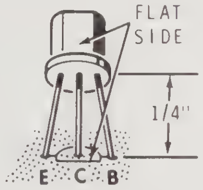


- (X) R202: 20 kΩ control (#10-390).
- (X) R208: 500 Ω control (#10-918).
- (X) R203: 10 kΩ control (#10-386).

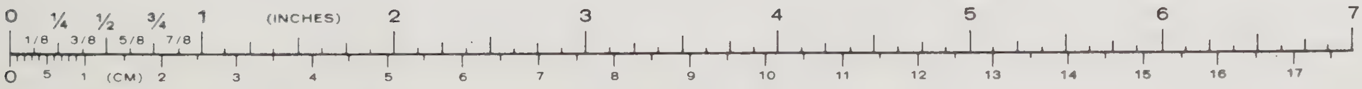


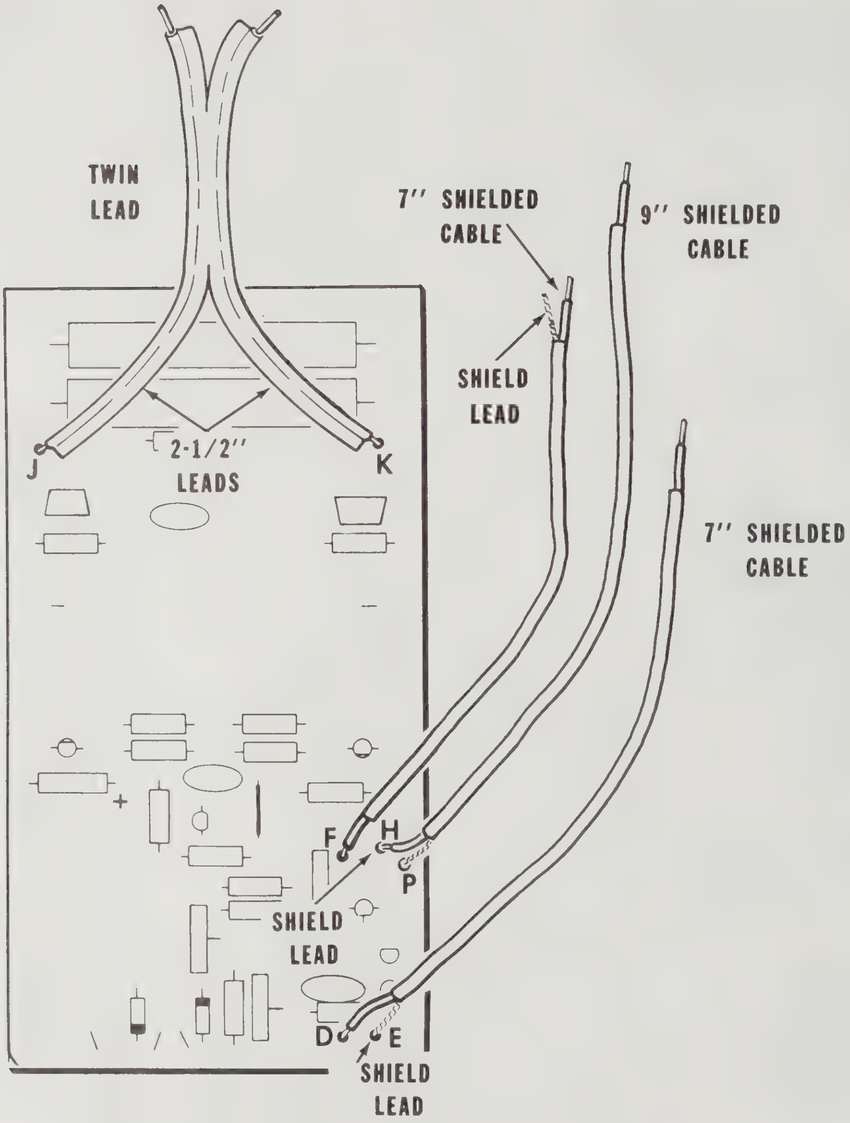
CONTINUE

NOTE: When you install the next two transistors, be sure to position each transistor with its flat over the outline of the flat on the circuit board. Then insert the leads into their correct E, C, and B holes. Solder the leads to the foil and cut off the excess lead lengths.

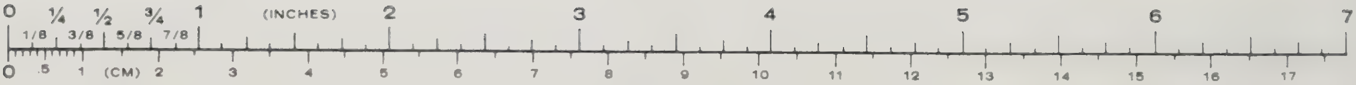


- (X) Q205: L842 transistor (#417-83).
- (X) Q206: L842 transistor (#417-83).





PICTORIAL 2-5


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 .5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Refer to Pictorial 2-5 for the following steps.

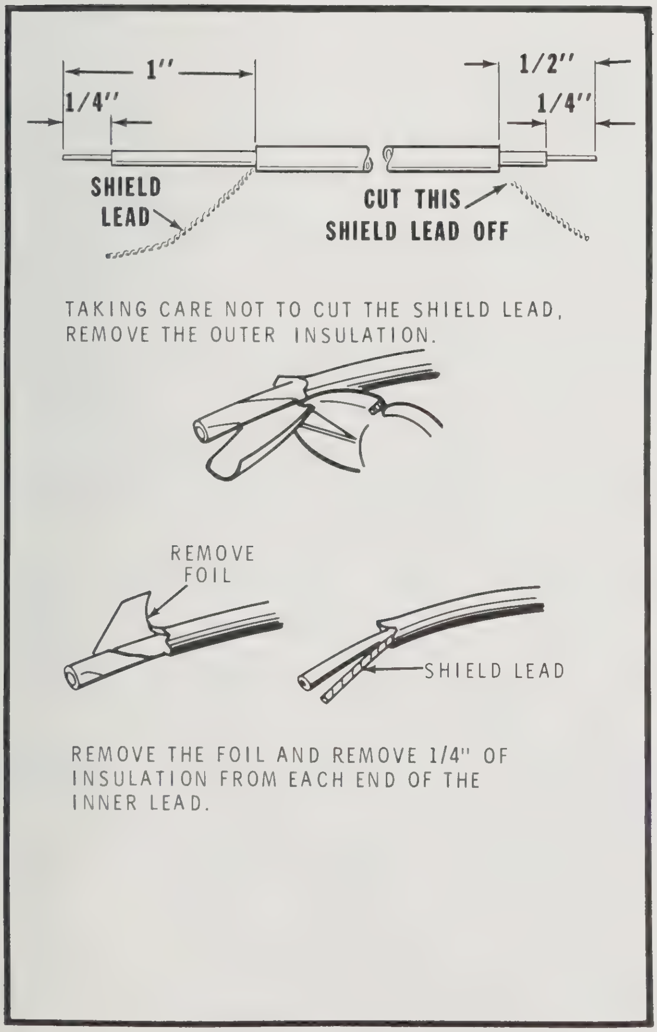
( ) Cut a 9" and two 7" shielded cables. Then refer to Detail 2-5A and prepare the ends of the shielded cables as shown. Note that the shield lead is cut off one end of each cable.

In each of the next two steps, connect the end of the shielded cable with the shield lead to the circuit board as follows:

(X) 7" shielded cable: Inner lead to hole D and the shield lead to hole E. Solder the leads to the foil.

(X) 9" shielded cable: Inner lead to hole H and the shield lead to hole P. Solder the leads to the foil.

( ) At the end of the remaining 7" shielded cable without a shield lead, connect the inner lead to circuit board hole F. Solder the lead to the foil.



TAKING CARE NOT TO CUT THE SHIELD LEAD, REMOVE THE OUTER INSULATION.

REMOVE THE FOIL AND REMOVE 1/4" OF INSULATION FROM EACH END OF THE INNER LEAD.

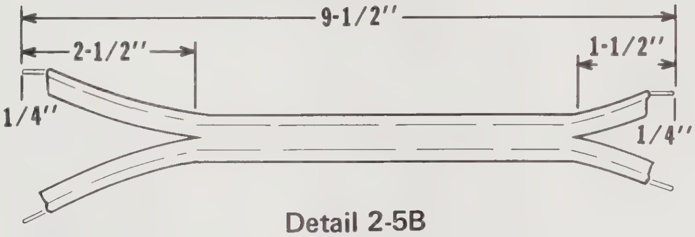
Detail 2-5A

( ) Prepare a 9-1/2" twin lead as follows, as shown in Detail 2-5B.

1. Cut the ends of the twin lead down the middle to form two leads at either end.

2. Remove 1/4" of insulation from each lead. Then twist together the fine wire strands at the end of each lead and apply just enough solder to hold them in place.

( ) Connect the 2-1/2" leads of the prepared twin lead to holes J and K on the circuit board. Solder the leads to the foil.



Detail 2-5B

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) "Cold" solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

( ) Transistors for the proper type and installation.

( ) Electrolytic capacitors for the correct position of the plus (+) end.

( ) Diodes for the correct position of the banded end.

( ) Lay the circuit board aside.

SWEEP-TRIGGER CIRCUIT BOARD

Unpack Pack #3 and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packed in an individual envelope with a part number on it should not be removed from the envelope until it is called for in a step. Do not throw away any packing material until all parts are accounted for.

PARTS LIST

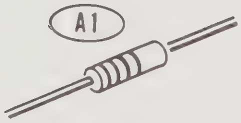
RESISTORS

1/2-Watt

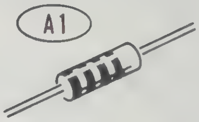
NOTE: The resistors may be packed in more than one envelope. Open all the resistor envelopes in this pack before you check the resistors against the Parts List.

All resistors have a 5% tolerance (gold fourth band) unless listed otherwise.

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
A1 (X)	3	2.7 Ω (red-violet-gold)	1-143	R325, R332, R323
A1 (X)	2	10 Ω (brown-black-black)	1-173	R309, R311
A1 (X)	2	100 Ω (brown-black-brown)	1-123	R308, R329
A1 (X)	1	200 Ω (red-black-brown)	1-137	R331
A1 (X)	1	470 Ω (yellow-violet-brown)	1-157	R318
A1 (X)	8	1000 Ω (brown-black-red)	1-172	R314, R315, R317, R319, R321, R324, R326, R327

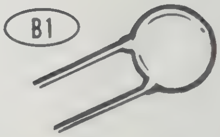


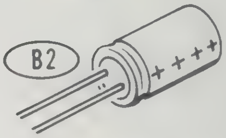
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Resistors (cont'd.)				
A1 (X)	1	2200 Ω (red-red-red)	1-57	R305
A1 (X)	2	2700 Ω (red-violet-red)	1-158	R312, R313
A1 (X)	2	4700 Ω (yellow-violet-red)	1-43	R306, R307
A1 (X)	1	12 kΩ (brown-red-orange)	1-109	R328
A1 (X)	1	27 kΩ (red-violet-orange)	1-124	R322
A1 (X)	1	47 kΩ (yellow-violet-orange)	1-115	R316
A1 (X)	1	100 kΩ (brown-black-yellow)	1-104	R302
A1 (X)	1	1 MΩ (brown-black-green)	1-101	R301



CAPACITORS

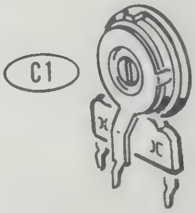
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
B1 (X)	1	470 pF disc	21-56	C302
B1 (X)	2	.01 μF disc	21-16	C301, C304
B2 (X)	2	10 μF electrolytic	25-115	C303, C306
B2 (X)	3	100 μF electrolytic	25-117	C305, C307, C308





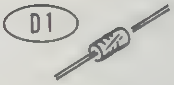
CONTROL

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
C1 (X)	2	10 kΩ	10-386	R303, R304



DIODES

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
D1 (X)	4	Germanium diode	56-602	D305,D306, D308,D309
D1 (X)	3	1N4149 diode	56-56	D303,D304, D307

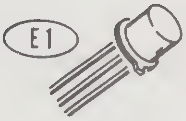


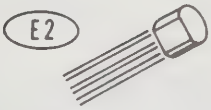
TRANSISTORS-INTEGRATED CIRCUITS

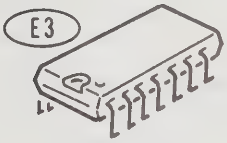
NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
E1 (X)	2	2N2369 transistor	417-154	Q310, Q312
E2 (X)	2	EL131 transistor	417-241	Q301, Q311
E2 (X)	10	MPSA20 transistor	417-801	Q302, Q303, Q304, Q305, Q306, Q307, Q308, Q309, ZD301, ZD302
E3 (X)	1	7472 IC	443-4	IC303
E3 (X)	1	74121 IC	443-22	IC304
E3 (X)	1	74122 IC	443-23	IC302
E3 (X)	1	74132 IC	443-625	IC301

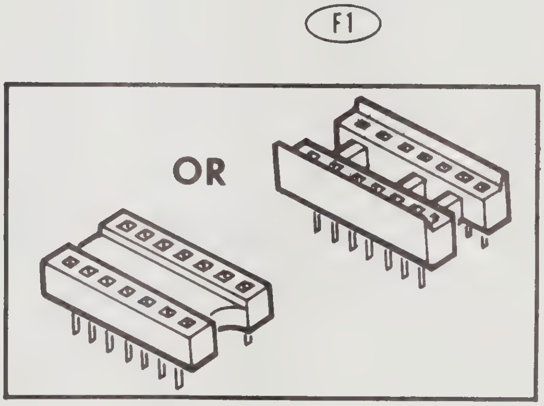






SOCKET

F1(X)	4	IC socket	434-298	



PARTS FROM THE FINAL PACK

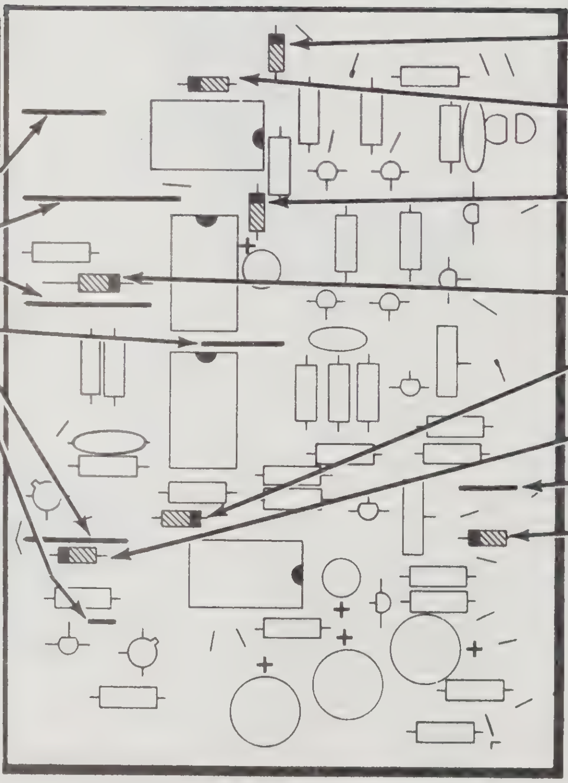
(X)	1	Sweep-trigger circuit board	85-1534-4
(X)	36"	Black wire	344-50
(X)	42"	Red wire	344-52
(X)	36"	Orange wire	344-53
(X)	54"	Yellow wire	344-54
(X)	36"	Violet wire	344-57
(X)	24"	Gray wire	344-58

NOTE: The prices shown on the separate "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

START

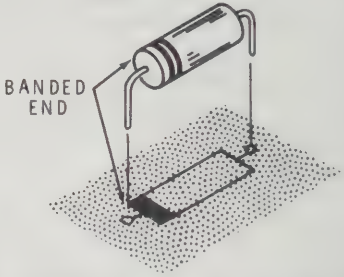
- (X) Locate the sweep-trigger circuit board (#85-1534-4) and position it as shown. Then complete the following steps.
- (X) 1" bare wire.
- (X) 1-1/2" bare wire.
- (X) 1-1/4" bare wire.
- (X) 1" bare wire.
- (X) 1-1/4" bare wire.
- (X) 1/2" bare wire.
- (X) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 3-1

CONTINUE

NOTE: When you install a diode, be sure to position the banded end as shown on the circuit board.



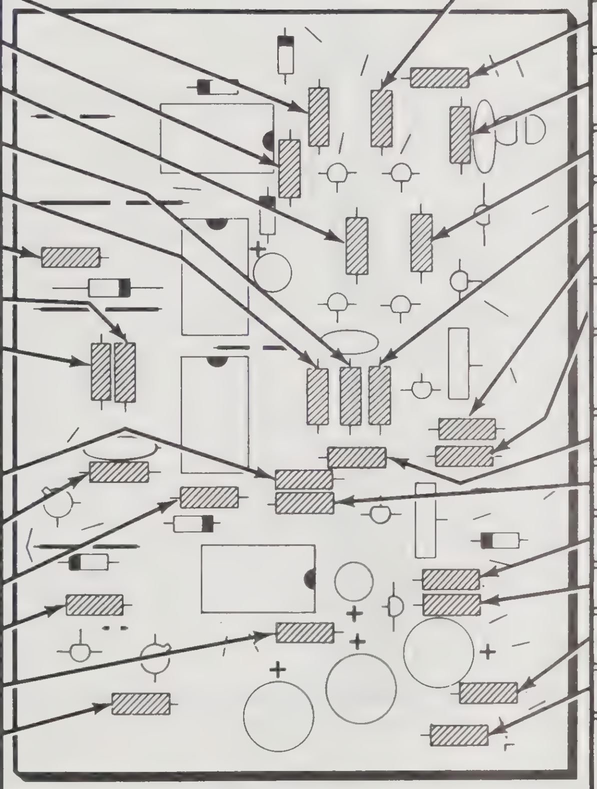
- (X) D306 : Germanium diode (#56-602).
- ( ) D309 : Germanium diode (#56-602).
- (X) D304 : 1N4149 diode (#56-56). Be sure to position the banded end as shown on the circuit board.
- (X) D305 : Germanium diode (#56-602).
- (X) D308 : Germanium diode (#56-602).
- (X) D307 : 1N4149 diode (#56-56).
- (X) 3/4" bare wire.
- (X) D303 : 1N4149 diode (#56-56).
- (X) Solder the lead to the foil and cut off the excess lead lengths.

0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 .5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

START

NOTE: Locate the 200 Ω (red-black-brown) resistor and set it aside until it is called for. Note that this resistor has the same color bands as the 1000 Ω (brown-black-red) resistor except in the opposite order.

- (X) R315: 1000 Ω (brown-black-red).
- (X) R316: 47 kΩ (yellow-violet-orange).
- (X) R313: 2700 Ω (red-violet-red).
- (X) R308: 100 Ω (brown-black-brown).
- (X) R311: 10 Ω (brown-black-black).
- (X) R331: 200 Ω (red-black-brown).
- (X) R326: 1000 Ω (brown-black-red).
- (X) R329: 100 Ω (brown-black-brown).
- (X) Solder the leads to the foil and cut off the excess lead lengths.
- (X) R319: 1000 Ω (brown-black-red).
- (X) R318: 470 Ω (yellow-violet-brown).
- (X) R317: 1000 Ω (brown-black-red).
- (X) R327: 1000 Ω (brown-black-red).
- (X) R322: 27 kΩ (red-violet-orange).
- (X) R328: 12 kΩ (brown-red-orange).
- (X) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

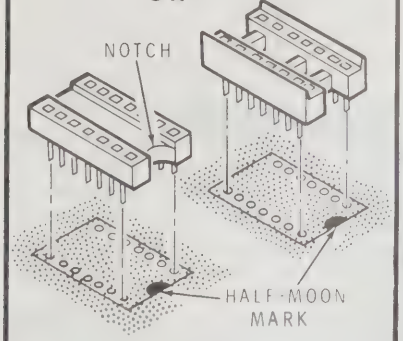
- (X) R314: 1000 Ω (brown-black-red).
- (X) R301: 1 MΩ (brown-black-green).
- (X) R302: 100 kΩ (brown-black-yellow).
- (X) R312: 2700 Ω (red-violet-red).
- (X) R309: 10 Ω (brown-black-black).
- (X) R305: 2200 Ω (red-red-red).
- (X) R306: 4700 Ω (yellow-violet-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) R307: 4700 Ω (yellow-violet-red).
- (X) R321: 1000 Ω (brown-black-red).
- (X) R324: 1000 Ω (brown-black-red).
- (X) R323: 2.7 Ω (red-violet-gold).
- ( ) R332: 2.7 Ω (red-violet-gold).
- (X) R325: 2.7 Ω (red-violet-gold).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-2

START

☐ IC socket at IC301. Insert the socket pins into the holes. The half-moon mark on the circuit board should still be visible after it is installed. Solder the pins to the foil.

OR



☑ IC socket at IC301.

☑ IC socket at IC302.

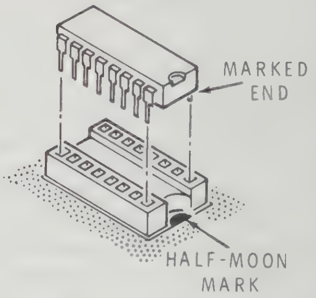
☑ IC socket at IC303.

☑ IC socket at IC304.

CONTINUE

NOTE: Install the IC's (integrated circuits) in the following manner:

1. Refer to Detail 3-3A and locate the pin 1 end of the IC. Position this end of the IC over the half-moon mark on the circuit board.
2. Carefully push the IC pins into the socket. Make sure all of the IC pins go into the socket. Seat the IC down as far as it will go.

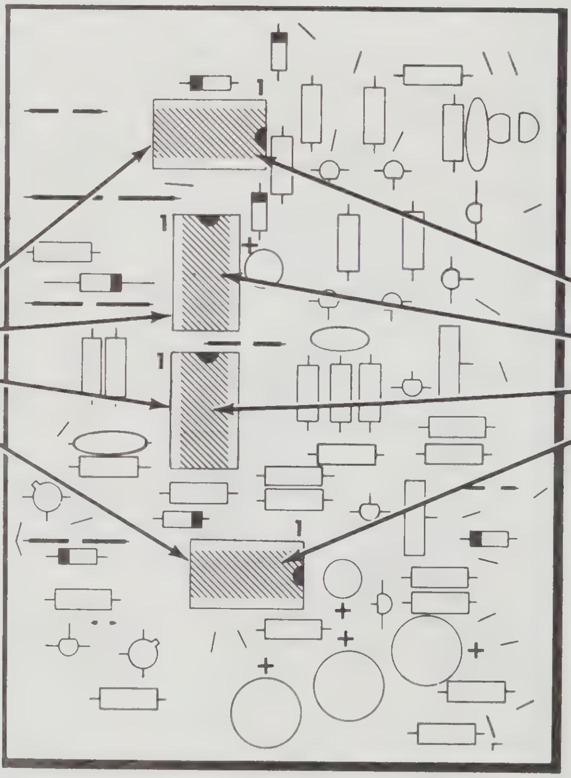


☑ IC301: 74132 IC (#443-625).

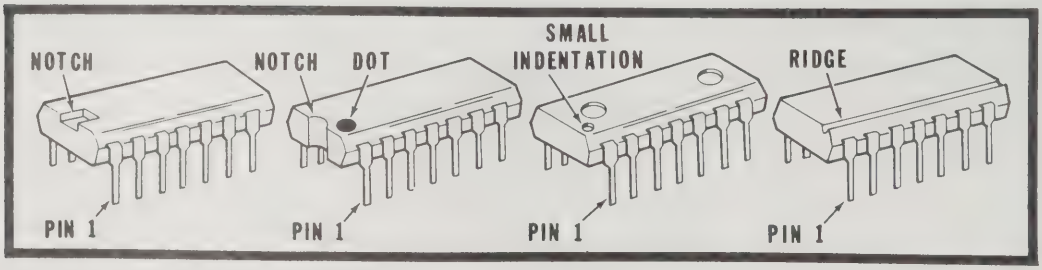
☑ IC302: 74122 IC (#443-23).

☑ IC303: 7472 IC (#443-4).

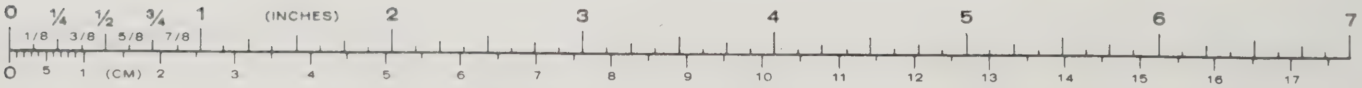
☑ IC304: 74121 IC (#443-22).



PICTORIAL 3-3

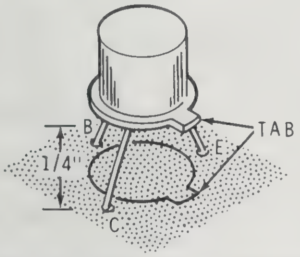


Detail 3-3A



START

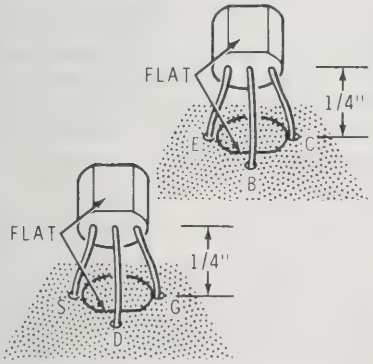
NOTE: When you install each of the next two transistors, line up the tab on the transistor with the outline of the tab on the circuit board. Then install the leads into their correct C, B, and E holes. Solder the leads to the foil and cut off the excess lead lengths.



(X) Q312: 2N2369 transistor (#417-154).

(/) Q310: 2N2369 transistor (#417-154).

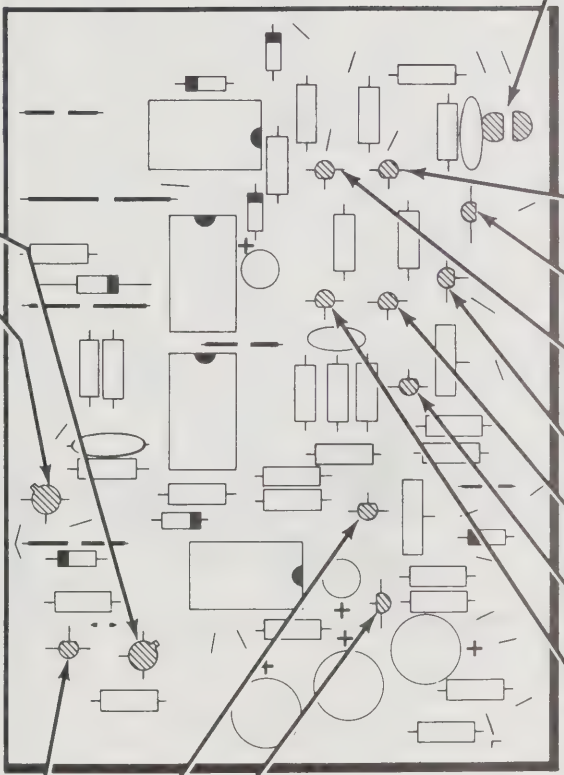
NOTE: When you install each of the following transistors, first line up the flat of the transistor with the outline of the flat on the circuit board. Then insert the transistor leads into their correct E, B, and C or S, D, and G holes. Solder the leads to the foil and cut off the excess lead lengths as you install each transistor.



(X) Q311: EL131 transistor (#417-241).

(X) Q308: MPSA20 transistor (#417-801).

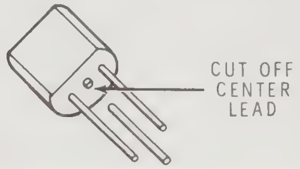
(X) Q309: MPSA20 transistor (#417-801).



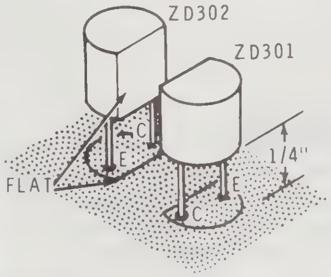
PICTORIAL 3-4

CONTINUE

(X) Cut the center leads off two MPSA20 transistors (#417-801).



(✓) ZD301, ZD302: Install the two prepared transistors at ZD301 and ZD302 as shown. Solder the leads to the foil and cut off the excess lead lengths.



(X) Q306: MPSA20 transistor (#417-801).

(✓) Q301: EL131 transistor (#417-241).

(X) Q307: MPSA20 transistor (#417-801).

(X) Q302: MPSA20 transistor (#417-801).

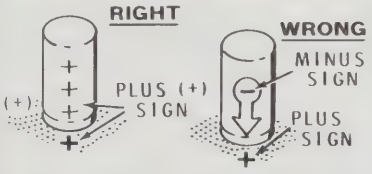
(X) Q304: MPSA20 transistor (#417-801).

(X) Q303: MPSA20 transistor (#417-801).

(/) Q305: MPSA20 transistor (#417-801).

START

NOTE: When you install the following electrolytic capacitors, be sure to position the plus (+) marked side of each capacitor as shown on the circuit board.



(X) C303: 10 µF electrolytic.

(X) C306: 10 µF electrolytic.

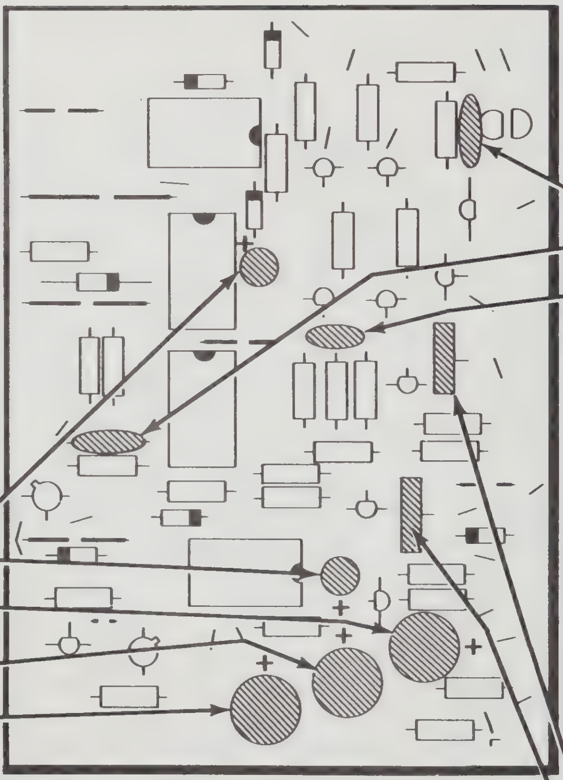
opposite →

(X) C307: 100 µF electrolytic.

(X) C308: 100 µF electrolytic.

(X) C305: 100 µF electrolytic.

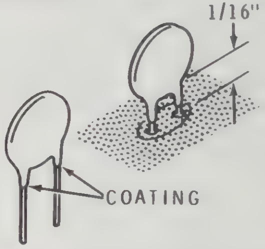
(X) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 3-5

CONTINUE

NOTE: A coating on disc capacitor leads next to the capacitor body will sometimes make soldering difficult. When you install one of these capacitors, position it 1/16" off the circuit board. This will prevent the coating from protruding through the circuit board.



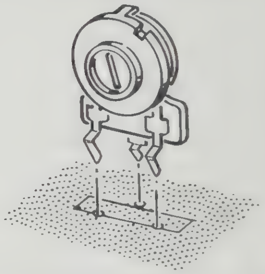
(X) C301: .01 µF disc.

(X) C304: .01 µF disc.

(X) C302: 470 pF disc.

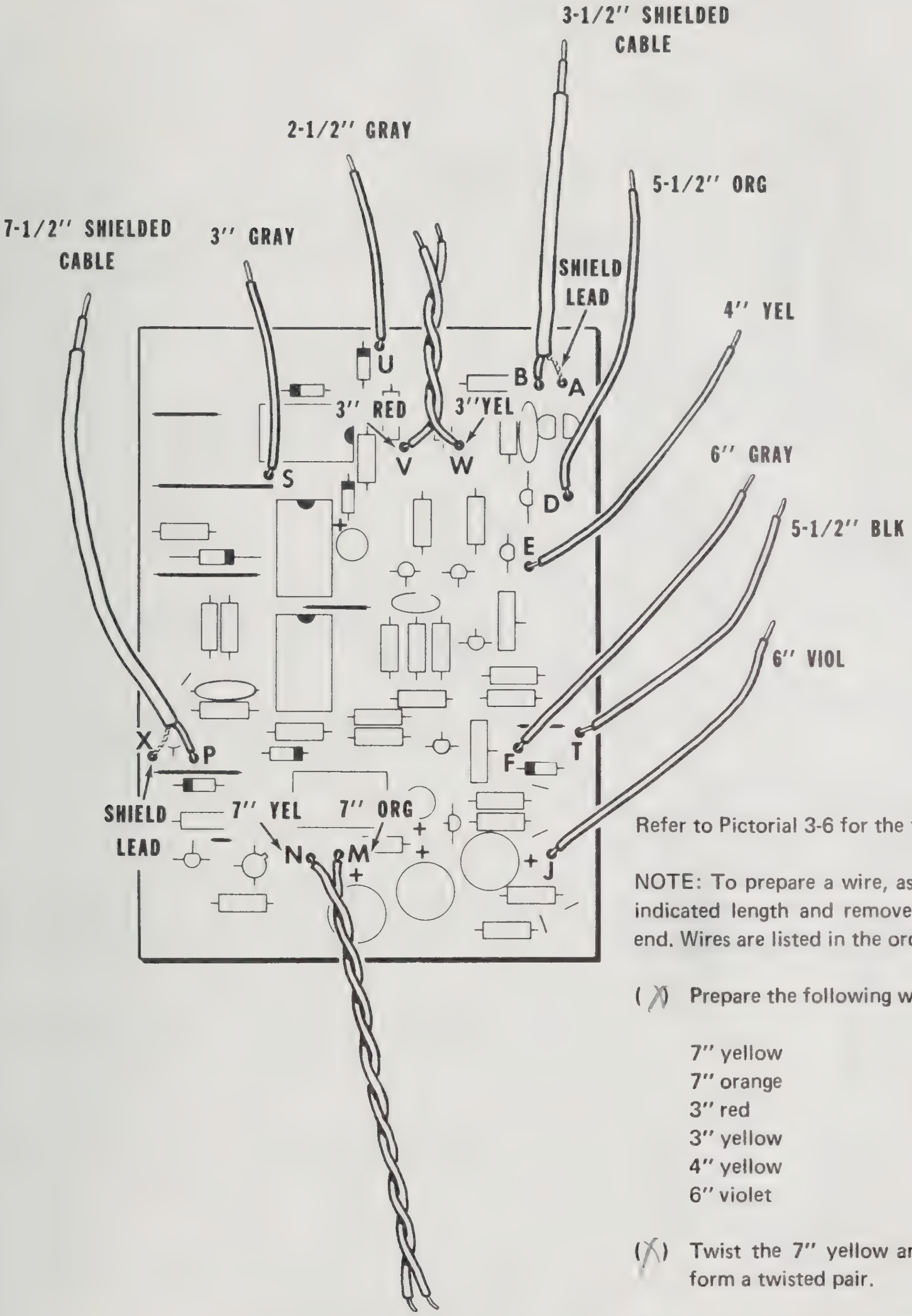
(X) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Solder the lugs to the foil as you install each of the folloiwng controls.



(X) R304: 10 kΩ control (#10-386).

(/) R303: 10 kΩ control (#10-386).



PICTORIAL 3-6

Refer to Pictorial 3-6 for the following steps.

NOTE: To prepare a wire, as in the next step, cut it to the indicated length and remove 1/4" of insulation from each end. Wires are listed in the order in which they are used.

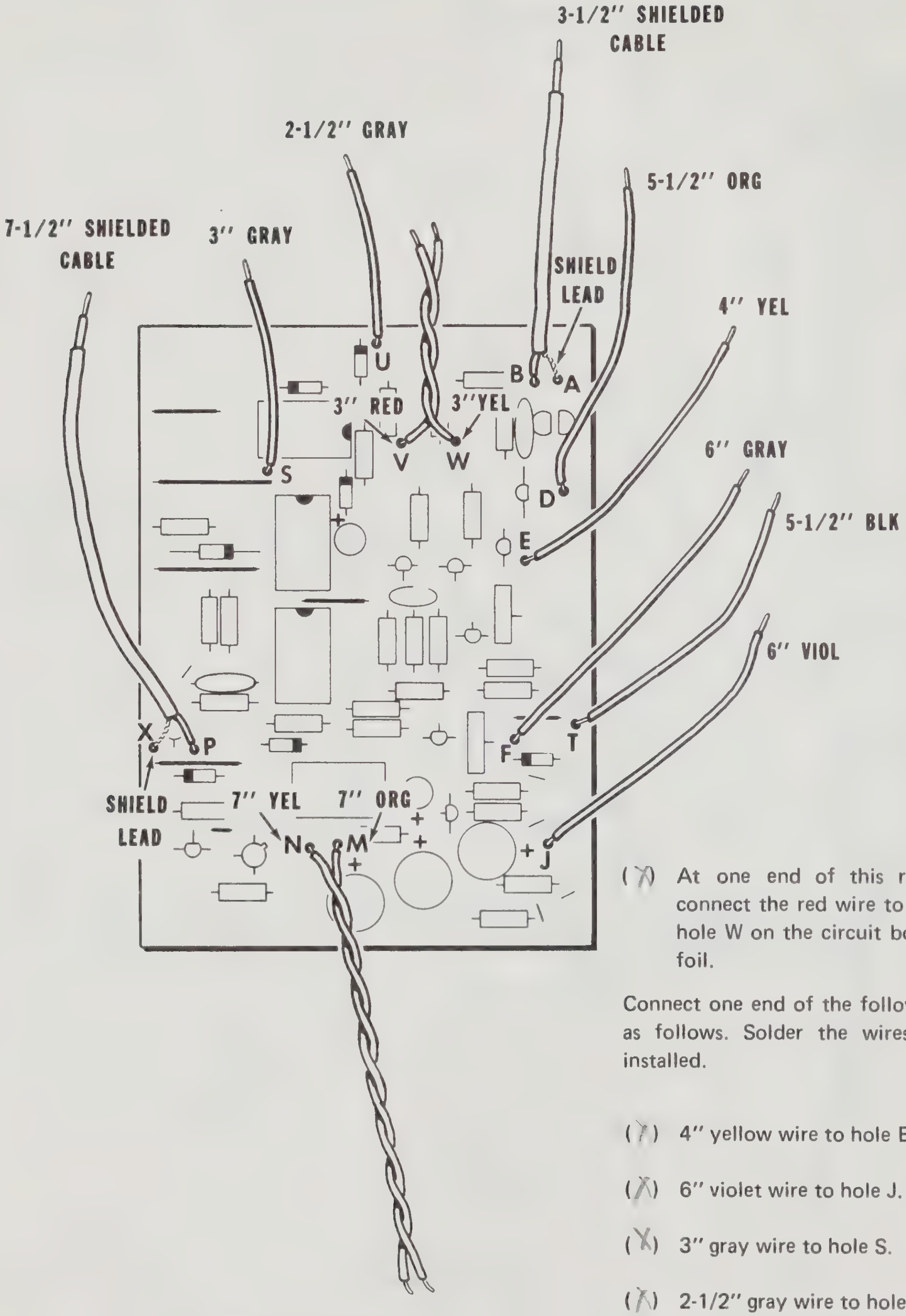
(X) Prepare the following wires:

7" yellow	3" gray
7" orange	2-1/2" gray
3" red	5-1/2" orange
3" yellow	6" gray
4" yellow	5-1/2" black
6" violet	

(X) Twist the 7" yellow and 7" orange wires together to form a twisted pair.

(X) At one end of this yellow and orange twisted pair, connect the yellow wire to hole N and the orange wire to hole M on the circuit board. Solder both wires to the foil.

(X) Twist the 3" red and 3" yellow wires together to form a twisted pair.



PICTORIAL 3-6
(Repeat)

(X) At one end of this red and yellow twisted pair, connect the red wire to hole V and the yellow wire to hole W on the circuit board. Solder both wires to the foil.

Connect one end of the following wires to the circuit board as follows. Solder the wires to the foil as each one is installed.

(✓) 4″ yellow wire to hole E.

(X) 6″ violet wire to hole J.

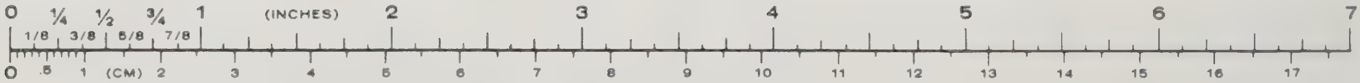
(X) 3″ gray wire to hole S.

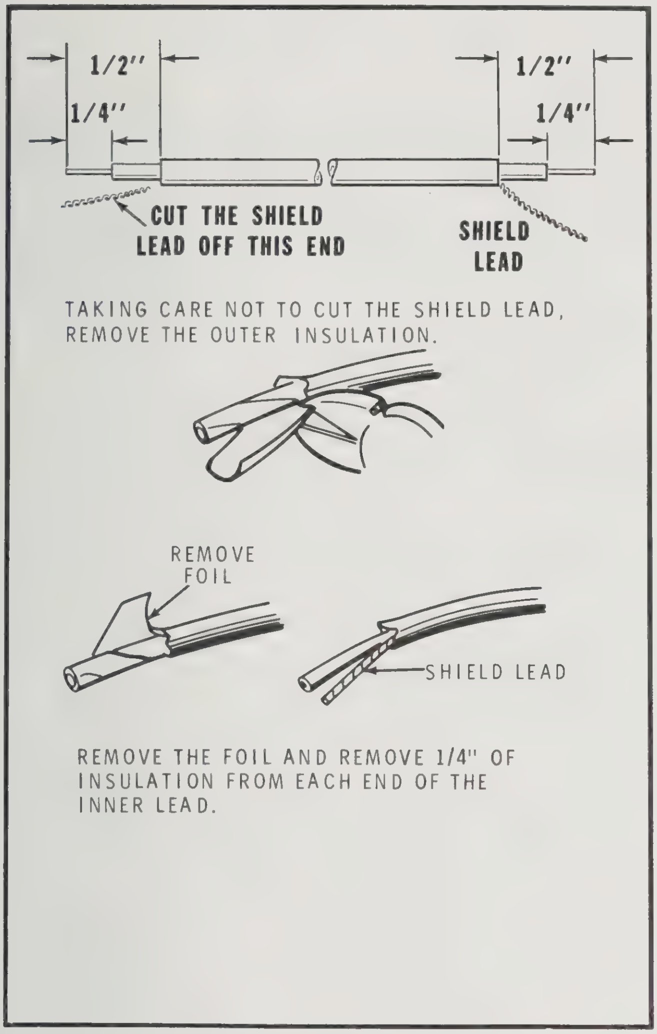
(X) 2-1/2″ gray wire to hole U.

(X) 5-1/2″ orange wire to hole D.

(X) 6″ gray wire to hole F.

(X) 5-1/2″ black wire to hole T.





TAKING CARE NOT TO CUT THE SHIELD LEAD, REMOVE THE OUTER INSULATION.

REMOVE THE FOIL AND REMOVE 1/4" OF INSULATION FROM EACH END OF THE INNER LEAD.

Detail 3-6A

(X) Refer to Detail 3-6A and prepare a 3-1/2" and a 7-1/2" shielded cable. Note that the shield lead is cut off one end of each cable.

Connect the end of the prepared shielded cables with the shield leads to the circuit board as follows:

(X) 3-1/2" shielded cable: Inner lead to hole B and the shield lead to hole A. Solder both leads to the foil.

(X) 7-1/2" shielded cable: Inner lead to hole P and the shield lead to hole X. Solder both leads to the foil.

(X) Cut any excess lead lengths from the foil side of the circuit board. The other end of these wires and cables will be connected later.

CIRCUIT BOARD CHECKOUT

Perform the following steps very carefully.

(X) Make sure that each diode is in its proper location and that the banded end is positioned as shown on the circuit board. A diode that is installed backward will not work.

(X) Make sure that all electrolytic capacitors are correctly positioned, as indicated by the plus (+) mark on the circuit board.

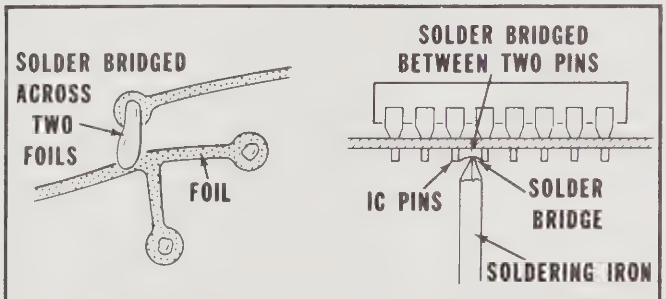
(X) Make sure that the correct transistor is installed at each transistor location. (Many different transistors look alike but will not operate if installed in the wrong place.) Also make sure the transistor leads are installed in their correct holes. A transistor incorrectly installed will not operate.

(X) Check each IC to make sure it is the correct IC for the location and that it is correctly installed.

(X) The biggest cause of trouble in kits is poor soldering. Carefully recheck your solder connections. Make sure all connections are soldered, and reheat any connections that look doubtful.

(X) Carefully check the circuit board foil for solder bridges. (See Detail 3-6B.)

(X) Lay the circuit board aside.


SOLDER BRIDGED ACROSS TWO FOILS
FOIL
SOLDER BRIDGED BETWEEN TWO PINS
IC PINS
SOLDER BRIDGE
SOLDERING IRON

TO REMOVE A SOLDER BRIDGE, HOLD THE CIRCUIT BOARD OVER THE SOLDERING IRON AND TOUCH THE BRIDGE WITH THE IRON. THE SOLDER WILL MELT AND FLOW DOWN THE IRON.

Detail 3-6B

POWER SUPPLY CIRCUIT BOARD

PARTS LIST

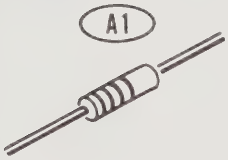
Unpack Pack #4 and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packed in an individual envelope with a part number on it should not be removed from the envelope until it is called for in a step. Do not throw away any packing material until all parts are accounted for.

RESISTORS

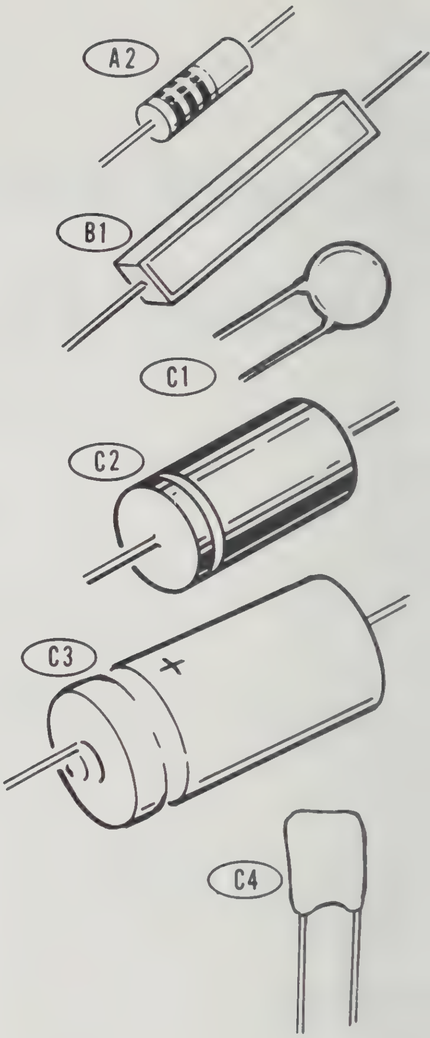
1/2-Watt

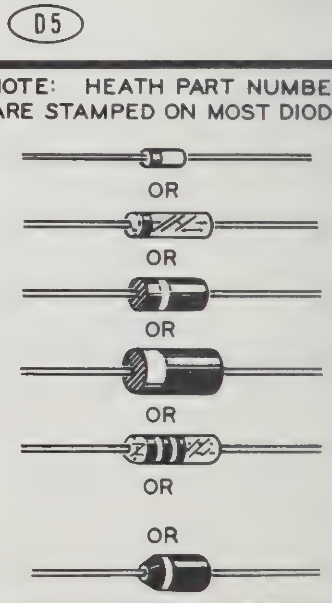
NOTE: All resistors have a 5% tolerance (gold fourth band) unless they are listed otherwise.

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
A1 (X)	1	200 Ω (red-black-brown)	1-137	R402
A1 (X)	1	1000 Ω (brown-black-red)	1-172	R406
A1 (X)	1	33 kΩ (orange-orange-orange)	1-76	R407
A1 (X)	1	220 kΩ (red-red-yellow)	1-59	R404



KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
1 Watt				
A2 (X)	2	470 kΩ, 10% (yellow-violet-yellow-silver)	1-32-1	R403, R405
A2 (X)	1	1.5 MΩ, 10% (brown-green-green-silver)	1-35-1	R408
Wire-wound (5 and 10 watt)				
B1 (X)	1	39 Ω, 10%, 5-watt	3-35-5	R411
B1 (X)	1	75 Ω, 10%, 5-watt	3-15-5	R412
B1 (X)	1	140 Ω, 10%, 5-watt	3-41-5	R409
B1 (X)	1	8000 Ω (8 k), 10%, 10-watt	3-37-10	R401
CAPACITORS				
C1 (X)	1	.02 μF disc	21-122	C403
C1 (X)	1	.01 μF disc	21-16	C401
C2 (X)	3	.1 μF paper	23-62	C404, C405, C406
C3 (X)	2	1200 μF electrolytic	25-241	C411, C412
C3 (X)	3	6000 μF electrolytic	25-272	C407, C408, C409
C4 (X)	1	.1 μF Mylar*	27-47	C402
DIODES				
D5 ( )	2	VR-9.1, 9.1 V zener	56-19	ZD415, ZD414
D5 ( )	1	1N751, 5.1 V zener	56-16	ZD413
D5 ( )	1	ZVR-68, 68 V zener	56-68	ZD403
D5 ( )	1	1N3017, 7.5 V zener	56-97	ZD412
D5 (X)	8	1N2071 diode	57-27	D404, D405, D406, D407, D408, D409, D410, D411
D5 (X)	2	MA2000 diode	57-52	D401, D402





NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.

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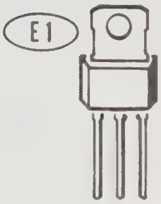
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

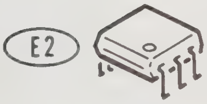
TRANSISTOR-INTEGRATED CIRCUIT

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

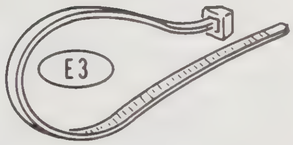
E1 (X)	2	MPSU10 transistor	417-834	Q401, Q402
E2 (X)	1	TIL115 IC	443-631	IC401

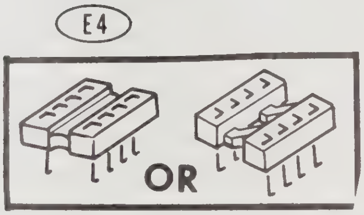




MISCELLANEOUS

E3 (X)	4	Cable tie	354-7
E4 (X)	1	IC socket	434-230





PARTS FROM THE FINAL PACK

(x)	1	Power supply circuit board	85-1535-1

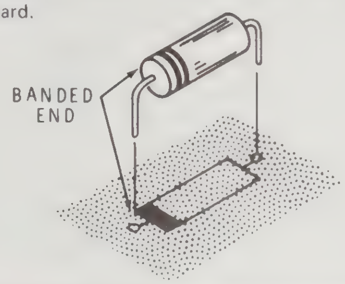
NOTE: The prices shown on the separate "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

START

(X) Locate the power supply circuit board (#85-1535-1) and position it as shown. Then complete the following steps.

NOTE: When you install the following diodes, be sure to position the banded end of each diode as it is shown on the circuit board.



(X) ZD413: 1N751 zener diode (#56-16).

(X) ZD414: VR-9.1 zener diode (#56-19).

(X) D401: MA2000 diode (#57-52).

(X) D402: MA2000 diode (#57-52).

(X) ZD415: VR-9.1 zener diode (#56-19).

(X) ZD412: 1N3017 diode (#56-97).

(X) ZD403: AVR-68 zener diode (#56-68).

(X) Solder the leads to the foil and cut off the excess lead lengths.

Install eight 1N2071 diodes (#52-27). Note that the banded ends are not all positioned the same way.

( ) D407.

( ) D406.

( ) D404.

( ) D405.

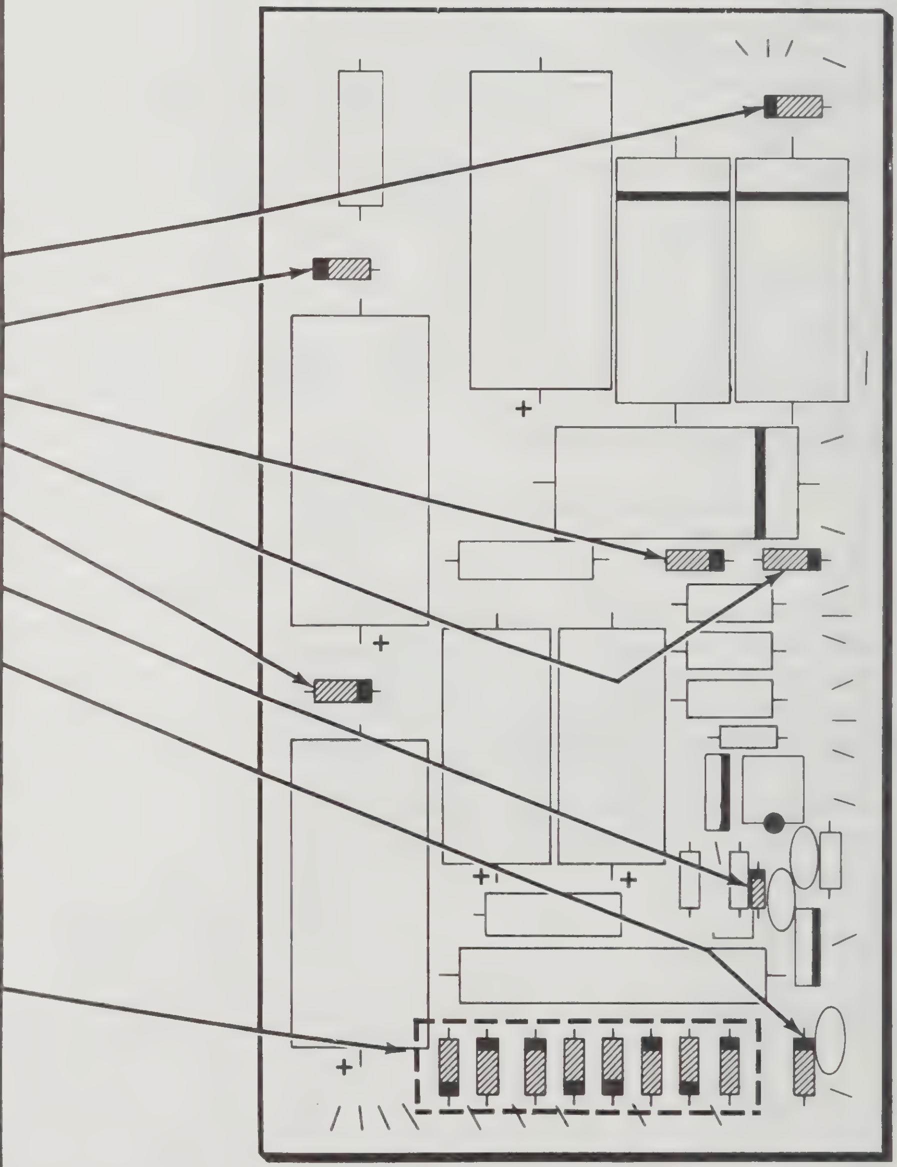
( ) D411.

( ) D410.

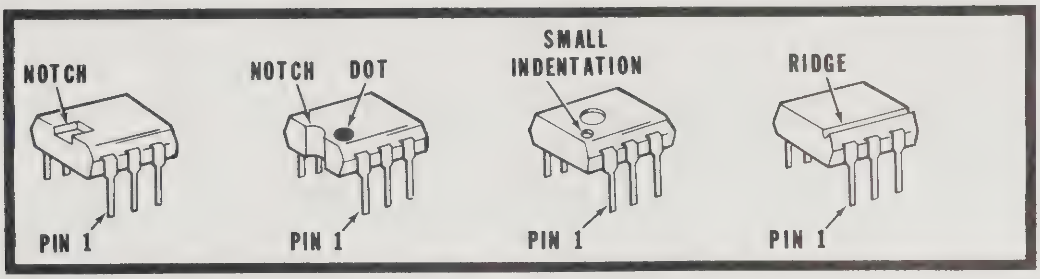
( ) D409.

( ) D408.

( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 4-1

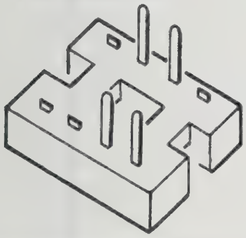


Detail 4-2A

START

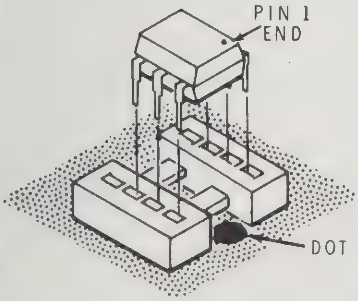
(☒) Locate the IC socket and position it so the pins face up as shown. The IC socket that is supplied with this kit may look slightly different than the one pictured.

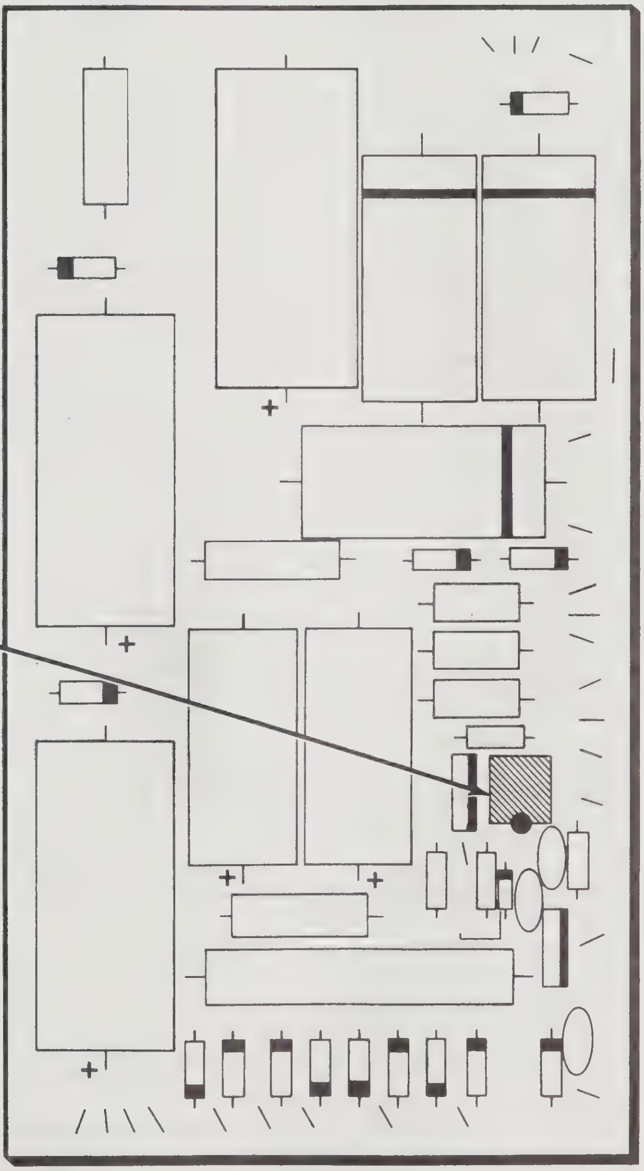
(☒) Cut four pins off the socket as shown. Make sure you cut off only the indicated pins.



(☒) Install the IC socket on the circuit board. Solder the socket pins to the foil.

(☒) IC401: TIL115 (#443-631). Refer to Detail 4-2A and locate the pin 1 end of the IC. Then position this end of the IC over the dot on the circuit board and push the IC pins into the socket. Two openings in the socket are not used.





PICTORIAL 4-2

START

(X) R408: 1.5 MΩ, 10%, 1-watt (brown-green-green-silver).

(X) R405: 470 kΩ, 10%, 1-watt (yellow-violet-yellow-silver).

(X) R403: 470 kΩ, 10%, 1-watt (yellow-violet-yellow-silver).

(X) R407: 33 kΩ (orange-orange-orange).

(X) Solder the leads to the foil and cut off the excess lead lengths.

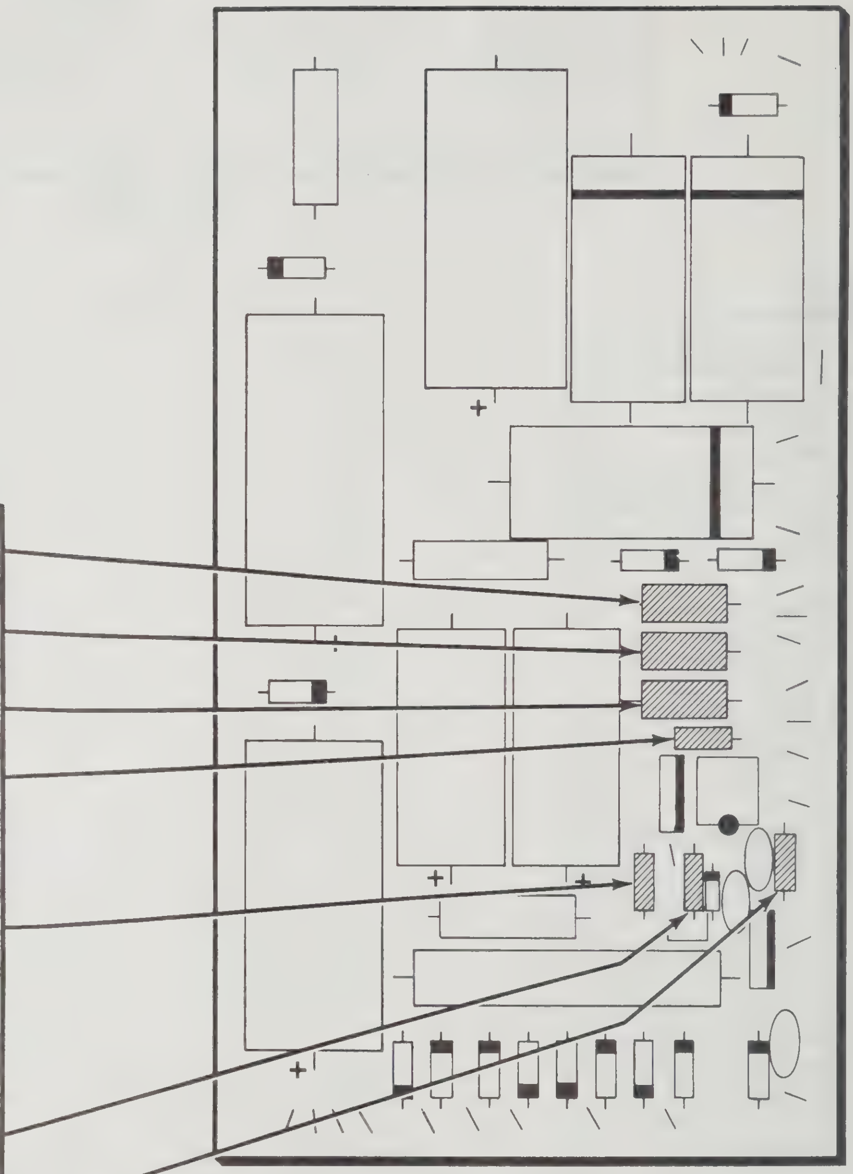
(X) R404: 220 kΩ (red-red-yellow).

NOTE: Do not confuse the next two resistors. They both have the same color bands, but starting from opposite ends of the resistor body.

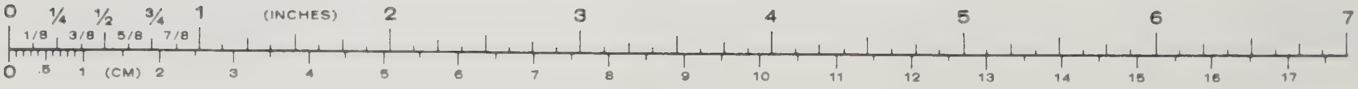
(X) R406: 1000 Ω (brown-black-red).

(X) R402: 200 Ω (red-black-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

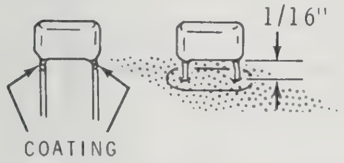


PICTORIAL 4-3



START

NOTE: A coating on disc capacitor leads near the body of the capacitor will sometimes make soldering difficult. When you install one of these capacitors, position it 1/16" off the circuit board. This will prevent the coating from protruding through the circuit board.

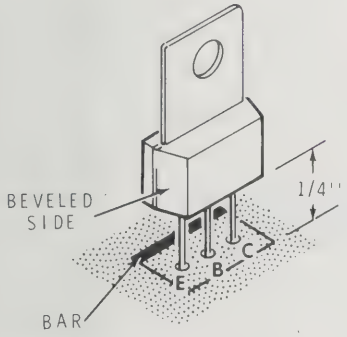


(X) C401: .01 μF disc.

(X) C402: .1 μF Mylar.

(X) Solder the leads to the foil and cut off the excess lead lengths.

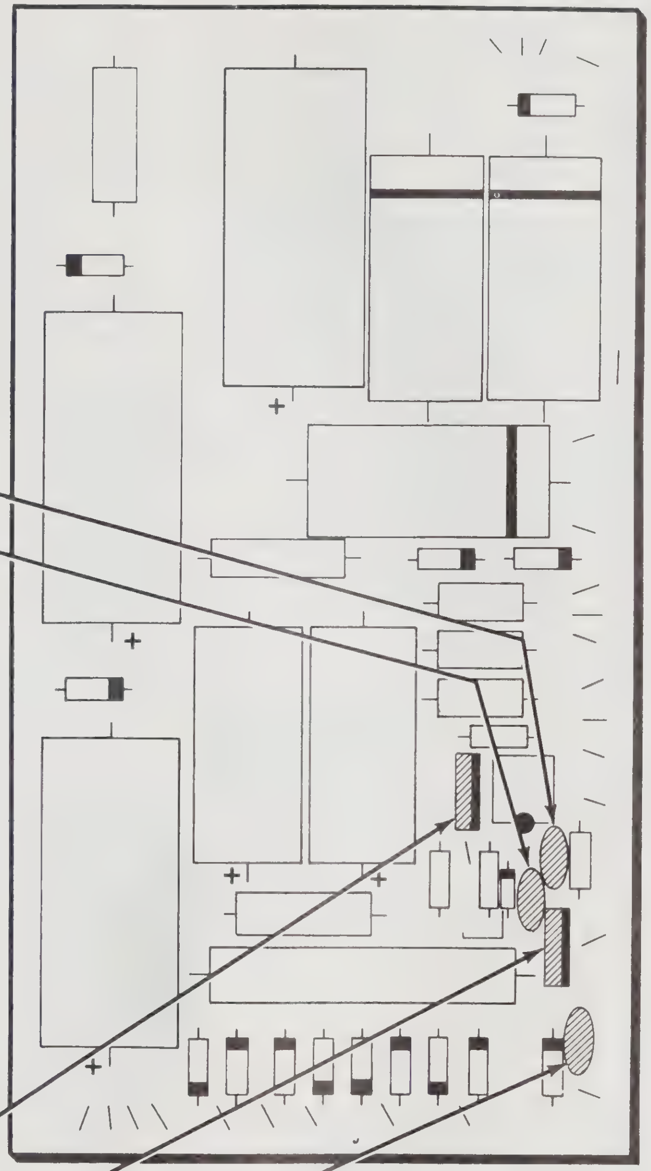
NOTE: Position each of the next two transistors over the outline on the circuit board so the beveled side is away from the bar in the outline. Then insert the leads into their correct E, B, and C holes. Solder the leads to the foil and cut off the excess lead lengths.



(X) Q402: MPSU10 transistor (#417-834).

(X) Q401: MPSU10 transistor (#417-834).

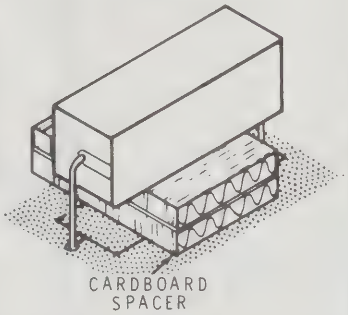
(X) C403: .02 μF disc. Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 4-4

START

(X) Cut two 1" x 1/2" pieces of cardboard from the shipping carton. Use these pieces of cardboard (one on top of the other) to space wire-wound resistors off the circuit board. As you install each resistor, solder the leads to the foil and cut off the excess lead lengths. Then remove the cardboard spacer.

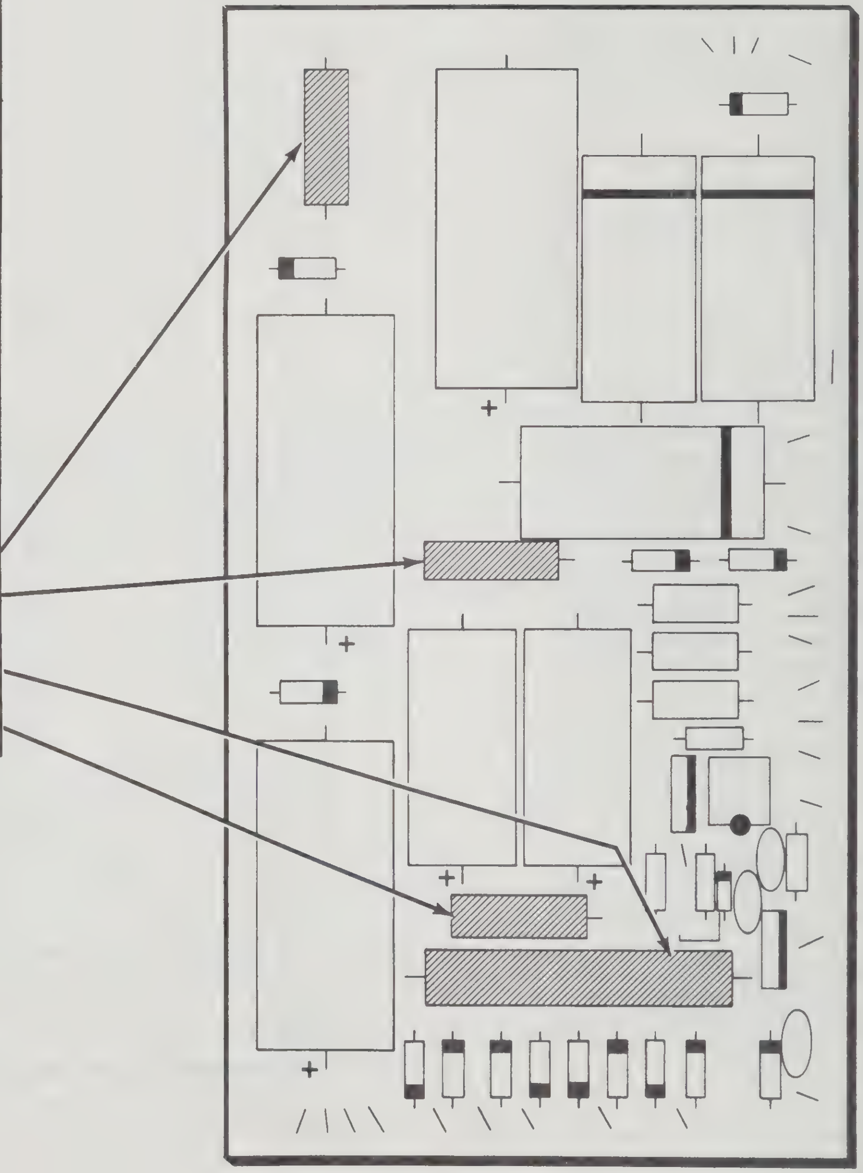


(X) R409: 140 Ω, 5-watt wire-wound.

(X) R411: 39 Ω, 5-watt wire-wound.

(X) R401: 8000 Ω (8k) 10-watt wire-wound.

(X) R412: 75 Ω, 5-watt wire-wound.

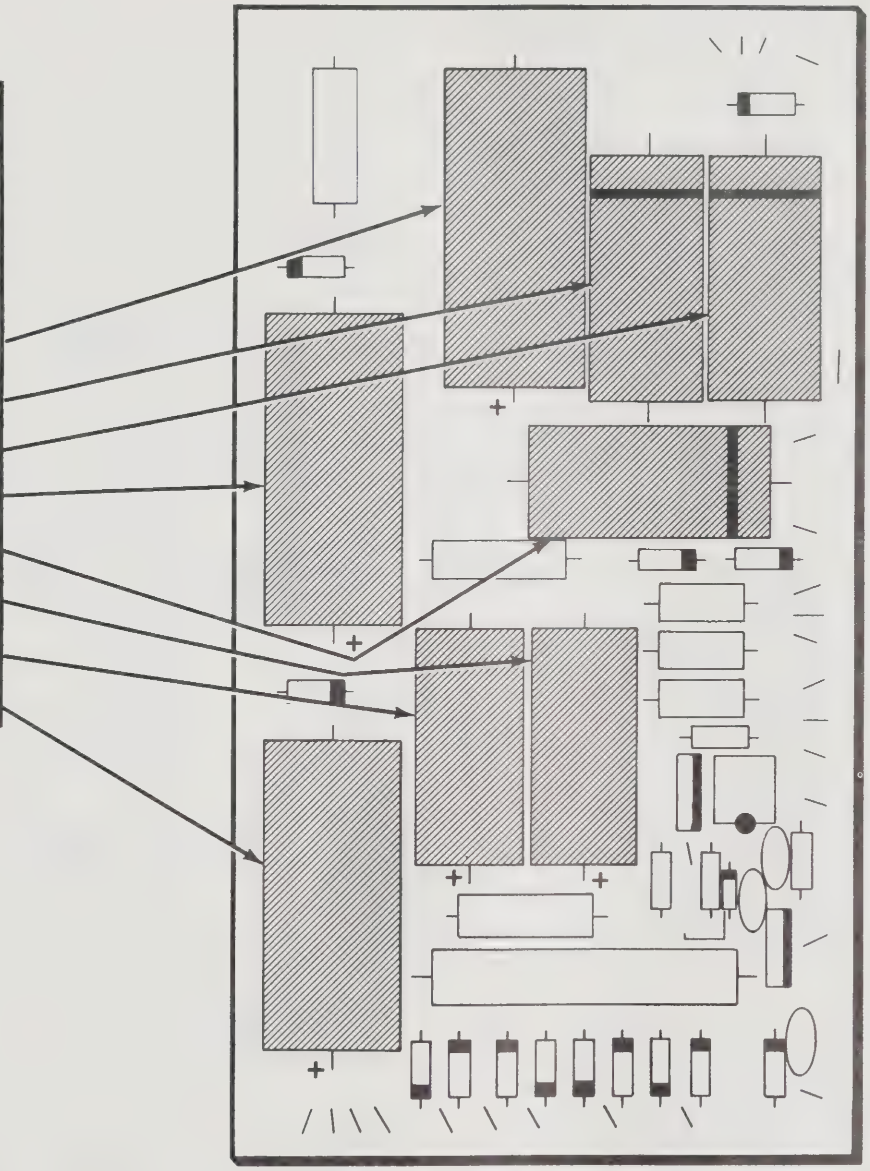


PICTORIAL 4-5

START

NOTE: When you install the following electrolytic and paper capacitors. Be sure to position the plus (+) marked or banded end of each capacitor toward the plus (+) mark or band on the circuit board. Solder the leads of each capacitor to the foil as you install it and cut off the excess lead lengths.

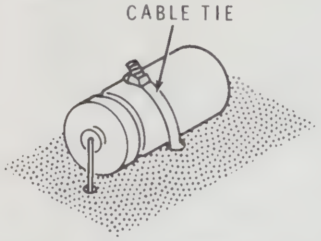
- (✓) C409: 6000 μF electrolytic.
- (✓) C404: .1 μF paper.
- (✓) C406: .1 μF paper.
- (✓) C408: 6000 μF electrolytic.
- (✓) C405: .1 μF paper.
- (✓) C412: 1200 μF electrolytic.
- (✓) C411: 1200 μF electrolytic.
- (✓) C407: 6000 μF electrolytic.



PICTORIAL 4-6

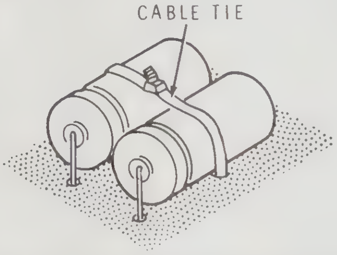
START

(✓) Thread a nylon cable tie through the holes in the circuit board and around capacitor C409. Make sure the rough side of the cable tie is toward the capacitors. Then pull the cable tie tight and cut off the excess lengths.



(✓) In the same manner, install a cable tie around capacitor C408.

(✓) Install a cable tie around capacitors C411 and C412.



(✓) Install a cable tie around capacitor C407.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions. Then lay the circuit board aside.

(✓) Unsoldered connections.

( ) "Cold" solder connections.

( ) Solder bridges between foils.

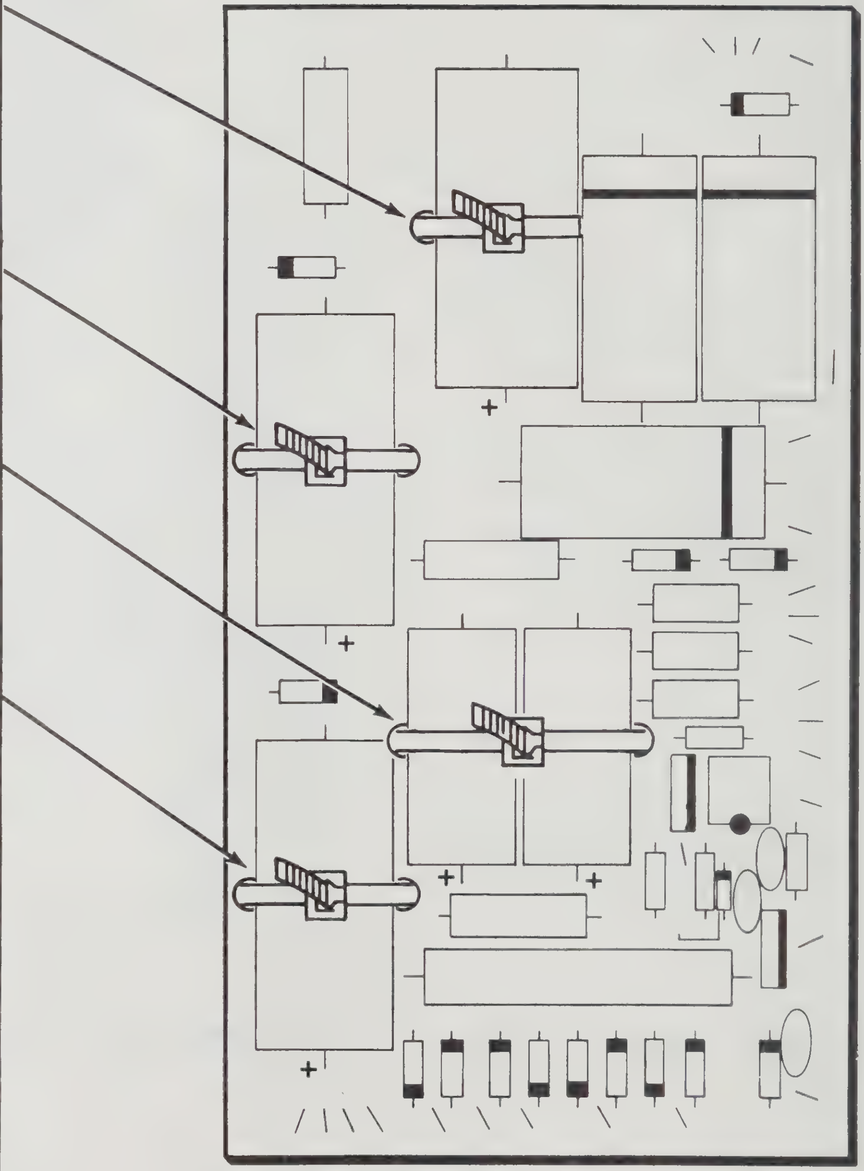
( ) Protruding leads which could touch together.

( ) Transistors for the proper installation.

( ) Electrolytic capacitors for the correct position of the positive (+) end.

( ) Diodes for the correct position of the banded end.

FINISH



PICTORIAL 4-7

CHASSIS

PARTS LIST

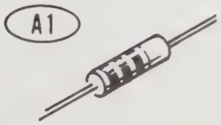
Remove the remaining parts from the Final Pack and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packed in an individual envelope with a part number on it should not be removed from the envelope until it is called for in a step. Do not throw away any packing material until all parts are accounted for.

RESISTORS

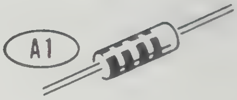
1/2-Watt

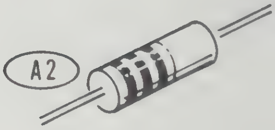
NOTE: All resistors have a 5% tolerance (gold fourth band) unless they are listed otherwise.

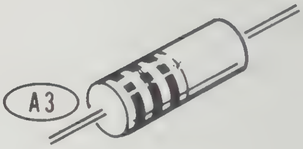
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
A1 (X)	1	100 Ω (brown-black-brown)	1-123	R11
A1 (X)	2	200 Ω (red-black-brown)	1-137	R6, R7
A1 (X)	1	220 Ω (red-red-brown)	1-147	R34
A1 (X)	1	620 Ω (blue-red-brown)	1-131	R5
A1 (X)	1	820 Ω (gray-red-brown)	1-79	R17
A1 (X)	1	2200 Ω (red-red-red)	1-57	R9
A1 (X)	1	9100 Ω (white-brown-red)	1-180	R16
A1 (X)	1	10 kΩ (brown-black-orange)	1-105	R3

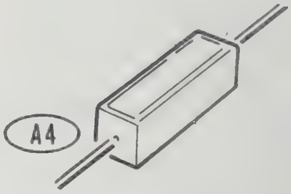


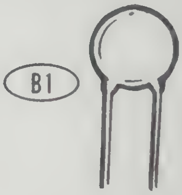
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Resistors (cont'd.)				
A1 (✓)	1	47 kΩ (yellow-violet-orange)	1-115	R31
A1 (✓)	1	91 kΩ (white-brown-orange)	1-127	R2
A1 (✓)	4	100 kΩ (brown-black-yellow)	1-104	R12, R15, R19, R26
A1 (✓)	2	910 kΩ (white-brown-yellow)	1-176	R1, R18
A1 (✓)	1	1 MΩ (brown-black-green)	1-101	R25
A1 (✓)	1	10 MΩ (brown-black-blue)	1-166	R27
Others				
A2 (✓)	1	3.3 MΩ, 10%, (orange-orange-green-silver) 1-watt	1-37-1	R23
A3 (✓)	1	1500 Ω, 10%, (brown-green-red-silver) 2-watt	1-14-2	R32
A4 (✓)	1	680 Ω, 10%, 5-watt	3-34-5	R33
CAPACITORS				
Disc				
B1 (✓)	1	5 pF	21-78	C14
B1 (✓)	1	33 pF	21-7	C3
B1 (✓)	1	47 pF	21-32	C15
B1 (✓)	1	100 pF	21-9	C16
B1 (✓)	1	420 pF	21-23	C13
B1 (✓)	1	500 pF	21-13	C17
B1 (✓)	1	1000 pF (.001 μF)	21-140	C18
B1 (✓)	2	.01 μF	21-16	C7, C19
B1 (✓)	1	.1 μF	21-95	C21



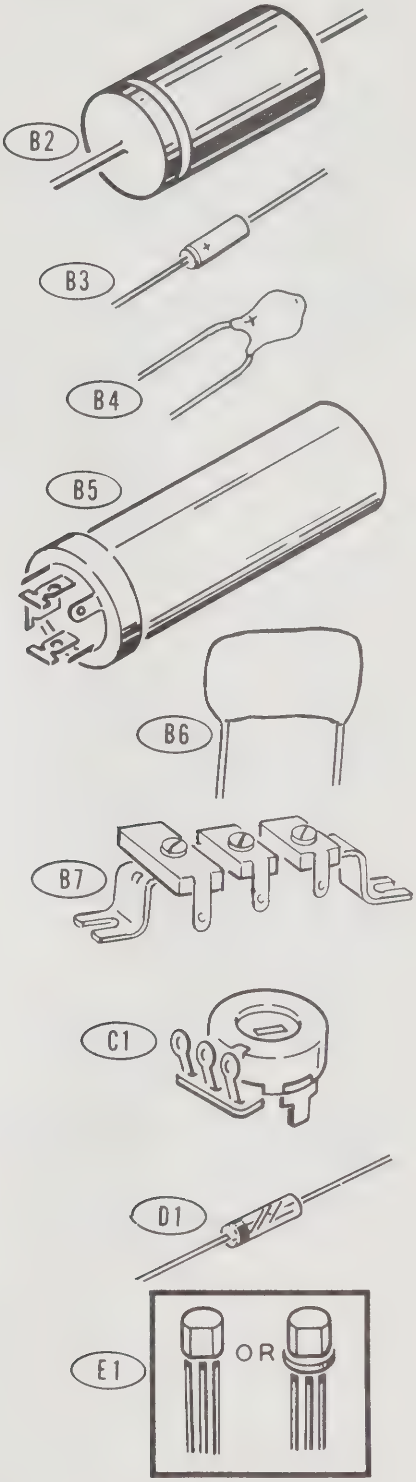








KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Paper				
B2 (X)	1	.047 µF	23-91	C23
Electrolytic				
B3 (X)	1	1 µF tantalum	25-197	C22
B4 (X)	1	4.7 µF tantalum	25-276	C8
B5 (X)	1	3-section electrolytic (100-100-300 µF)	25-228	C25
Mylar*				
B6 (X)	1	4700 pF (.0047 µF)	27-104	C12
B6 (X)	1	.047 µF	27-43	C11
B6 (X)	2	.1 µF	27-28	C1, C6
B6 (X)	2	.47 µF	27-61	C9, C24
Trimmer				
B7 (X)	1	3-section trimmer	31-70	C2
CONTROLS				
C1 (X)	2	1000 Ω (1 k)	10-1032	R8, R22
C1 (X)	1	10 kΩ	10-1031	R13
C1 (X)	1	25 kΩ	10-1024	R28
C1 (X)	1	150 kΩ	10-282	R29
C1 (X)	1	1 MΩ	10-1033	R24
DIODES				
D1 (X)	1	VR-9.1, 9.1 V zener	56-19	ZD2
D1 (X)	1	1N4149 diode	56-56	D1
TRANSISTOR				
E1 (X)	1	X29A829	417-201	Q1



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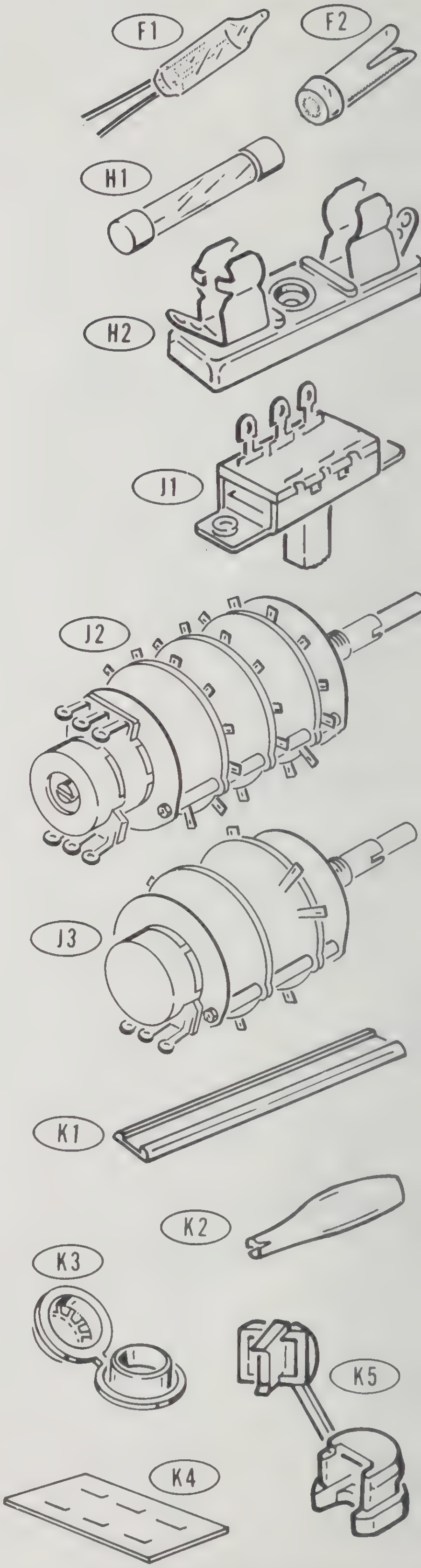
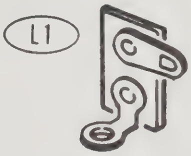
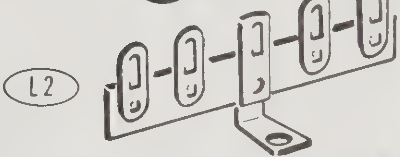
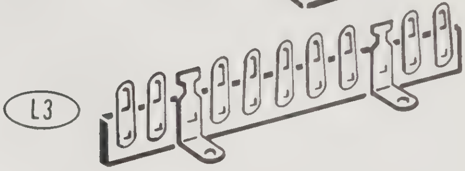
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
TUBE-LAMP-LENS				
(X)	1	CRT (Cathode Ray Tube)	411-815	CRT
F1 (X)	1	Neon lamp	412-15	PL1
F2 (X)	1	Lens	413-10	
FUSES-FUSEHOLDER				
H1 (X)	1	1/8-ampere slow-blow fuse	421-26	F1
H1 (X)	1	1/4-ampere slow-blow fuse	421-33	F1
H2 (X)	1	Fuseholder	422-1	
SWITCHES				
J1 (X)	2	3-lug slide switch	60-4	SW5, SW8
(X)	1	6-lug slide switch	60-2	SW7
(X)	3	8-lug slide switch	60-73	SW1, SW3, SW4
J2 (X)	1	3-section rotary switch/controls	63-1217	SW6, R14, R21
J3 (X)	1	2-section rotary switch/control	63-1216	SW2, R4
INSULATORS				
K1 (X)	1	Rubber strip	73-5	
K2 (X)	2	Alligator clip insulator	73-34	
K3 (X)	13	Plastic grommet	73-45	
K4 (X)	1	Switch insulator	75-52	
K5 (X)	1	Strain relief	75-71	
(X)	1	Insulating paper	75-108	

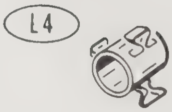


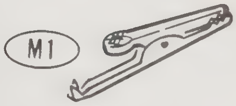
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
TERMINAL STRIPS				
L1 ( )	1	1-lug terminal strip	431-15	
L2 ( )	3	5-lug terminal strip	431-42	
L3 ( )	1	11-lug terminal strip	431-49	
L4 ( )	1	Terminal collar	431-82	
CONNECTOR-SOCKET-JACKS				
M1 ( )	2	Alligator clip	260-16	
M2 ( )	1	BNC connector with hardware	432-892	
M3 ( )	1	CRT socket	434-41	
M4 ( )	3	Red banana jack with hardware	436-11	
M4 ( )	1	Black banana jack with hardware	436-22	
TRANSFORMERS				
( )	1	High voltage transformer	54-282	T1
( )	1	Low voltage transformer	54-880	T2

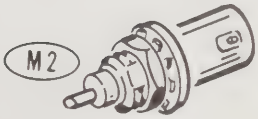


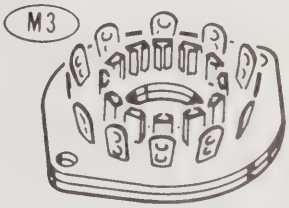


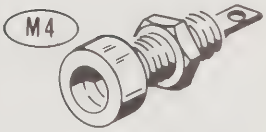












HARDWARE

NOTE: The hardware may be in more than one packet. Open all the hardware packets in this pack before you check the hardware against the Parts List.

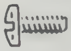
Hardware is shown actual size. To identify a piece of hardware, place it over the illustration.

#4 Hardware

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
N1 (✓)	4	4-40 x 1/4" screw	250-52	
N2 (✓)	4	4-40 nut	252-15	
N3 (✓)	4	#4 lockwasher	254-9	

#6 Hardware

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
N4 (✓)	10	6-32 x 3/16" screw	250-7	
N5 (✓)	16	#6 x 1/4" hex head sheet metal screw	250-365	
N6 (✓)	2	6-32 x 3/8" flat head screw	250-32	
N7 (✓)	8	6-32 x 3/8" screw	250-89	
N8 (✓)	3	#6 x 1/2" self-tapping screw	250-591	
N9 (✓)	19	6-32 x 5/8" screw	250-26	
N10 (✓)	1	6-32 x 2" screw	250-27	
N11 ( )	23	6-32 nut	252-3	
N12 ( )	9	#6 lockwasher	254-1	
N13 ( )	16	Short threaded spacer	255-103	
N14 ( )	2	Long threaded spacer	255-117	
N15 ( )	4	#6 solder lug	259-1	

N1


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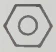

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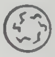

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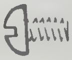

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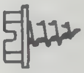

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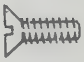

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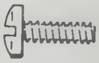

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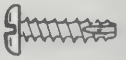

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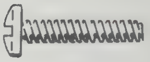

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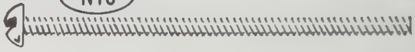

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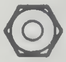

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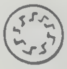

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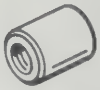

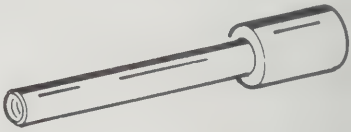

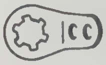
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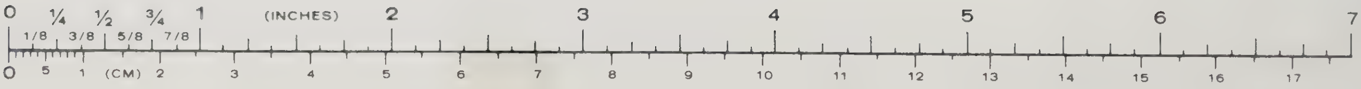

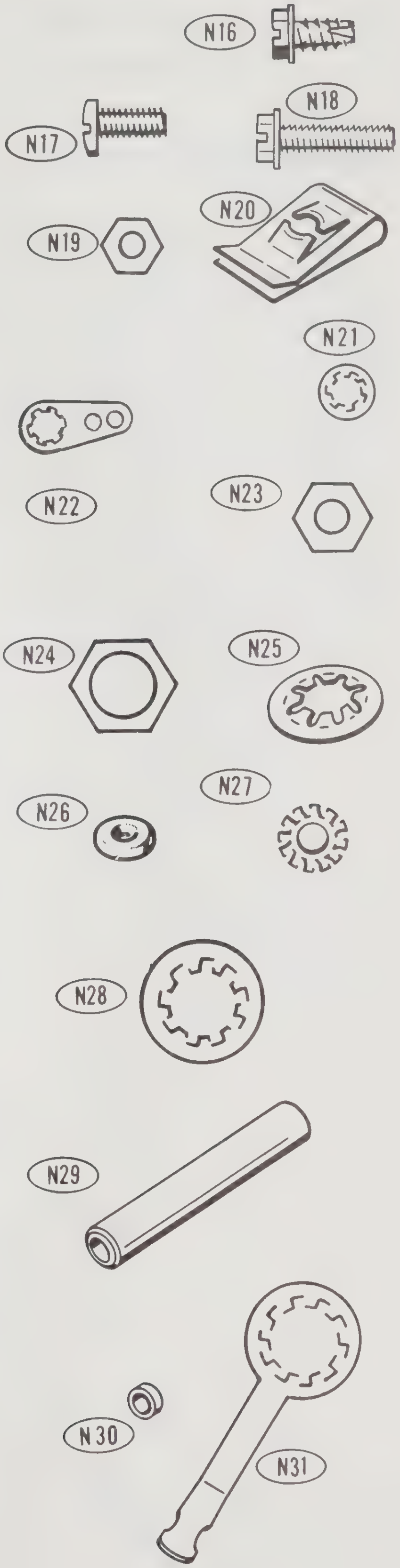

#8 Hardware

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
N16 (X)	4	#8 x 5/16" hex head sheet metal screw	250-1232	
N17 (X)	9	8-32 x 3/8" screw	250-137	
N18 (X)	8	#8 x 5/8" hex head sheet metal screw	250-1138	
N19 (X)	5	8-32 nut	252-4	
N20 (X)	8	8-32 Speed-Nut*	252-68	
N21 (X)	4	#8 lockwasher	254-2	
N22 (X)	1	#8 solder lug	259-2	

Other Hardware

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
N23 (X)	2	10-32 nut	252-5	
N24 (X)	2	Control nut	252-7	
N25 (X)	1	Push-on nut	252-73	
N26 (X)	1	Rubber O-ring	253-115	
N27 (X)	2	#10 lockwasher	254-21	
N28 (X)	1	Control lockwasher	254-4	
N29 (X)	1	1-1/2" spacer	255-10	
N30 (X)	10	1/16" spacer	255-74	
N31 (X)	1	Control solder lug	259-10	

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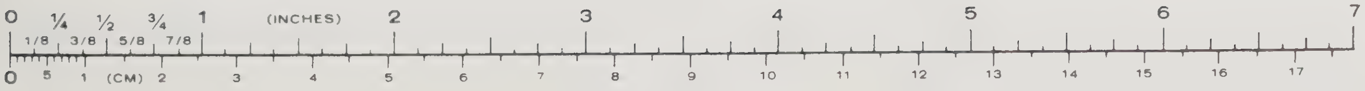
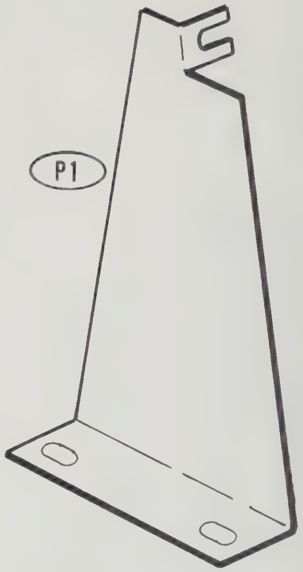
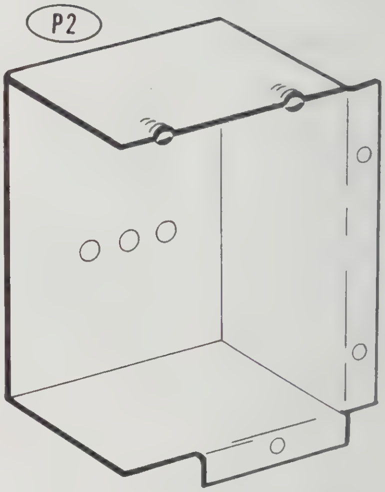
*Registered Trademark, Tinnerman Co.

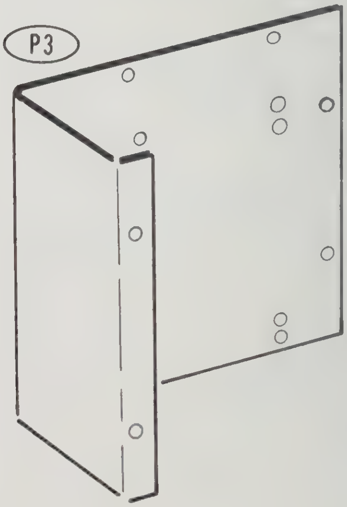


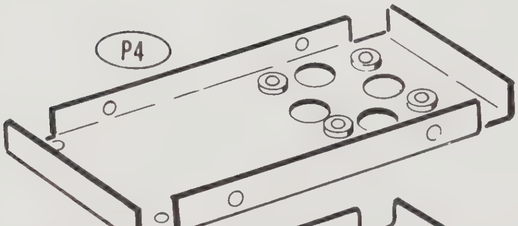
CABINET-CHASSIS PARTS

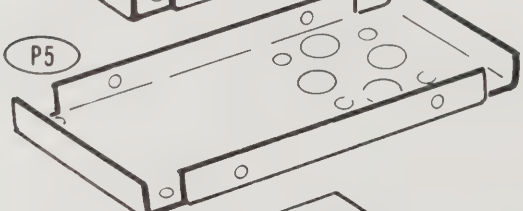
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
☒	1	Cabinet	92-609	
☒	1	Plastic front subpanel	92-608	
☒	1	Chassis	200-1287 ←1281	
P1 ☒	1	Front panel bracket	204-2141	
P2 ☒	1	Input shield	206-1169	
→ ☐	1	Front panel	390-1203 — 390-1256	
P3 ☒	2	Transformer cage side panel	206-1161	
P4 ☒	1	Transformer cage bottom panel	206-1162	
P5 ☒	1	Transformer cage top panel	206-1171	
P6 ☒	1	Grommet plate	206-1163	
P7 ☒	2	CRT clamp	207-1	
☒	1	Plastic handle	211-49	

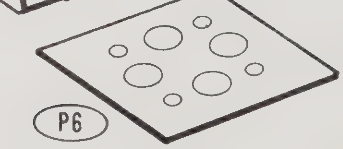


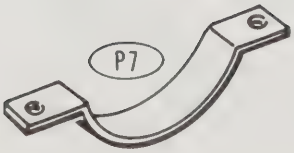






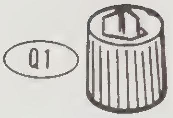


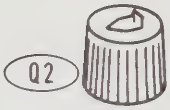


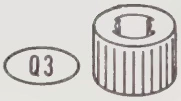


KNOB INSERTS-KNOBS

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Q1 (X)	5	Knob insert (large triangular hole)	455-50	
Q2 (X)	2	Knob insert (small triangular hole)	455-51	
Q3 (X)	2	Knob insert (round hole)	455-52	
(X)	2	Large black knob	462-361	
(X)	5	Small black knob	462-362	
(X)	2	Red knob	462-363	

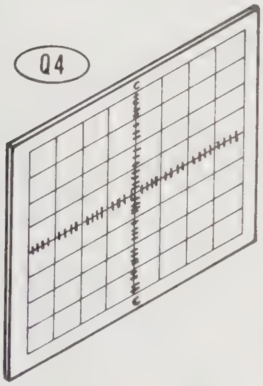






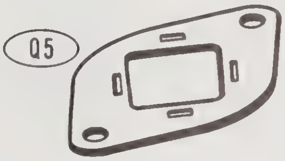
LABELS

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
(X)	1	"Danger High Voltage" label	390-147	
(X)	1	Fuse replacement label	390-1255	
(X)	1	Fuse label	390-1185	
→)	1	Blue and white label	391-34	



MISCELLANEOUS

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
(X)	1	Line cord	89-23	
(X)	1	Test cable	134-237	
(X)	1	Wiring harness	134-907	
(X)	1	Felt strip	330-18	
(X)	20"	Blue wire	344-13	
(X)	7"	White wire	344-59	
(X)	7"	Sleeving	346-1	
Q4 (X)	1	Graticule	414-36	
Q5 (X)	1	Capacitor mounting plate	481-1	
(X)	1	Nut starter	490-5	



NOTE: The prices shown on the separate "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

TRANSFORMER CAGE ASSEMBLY

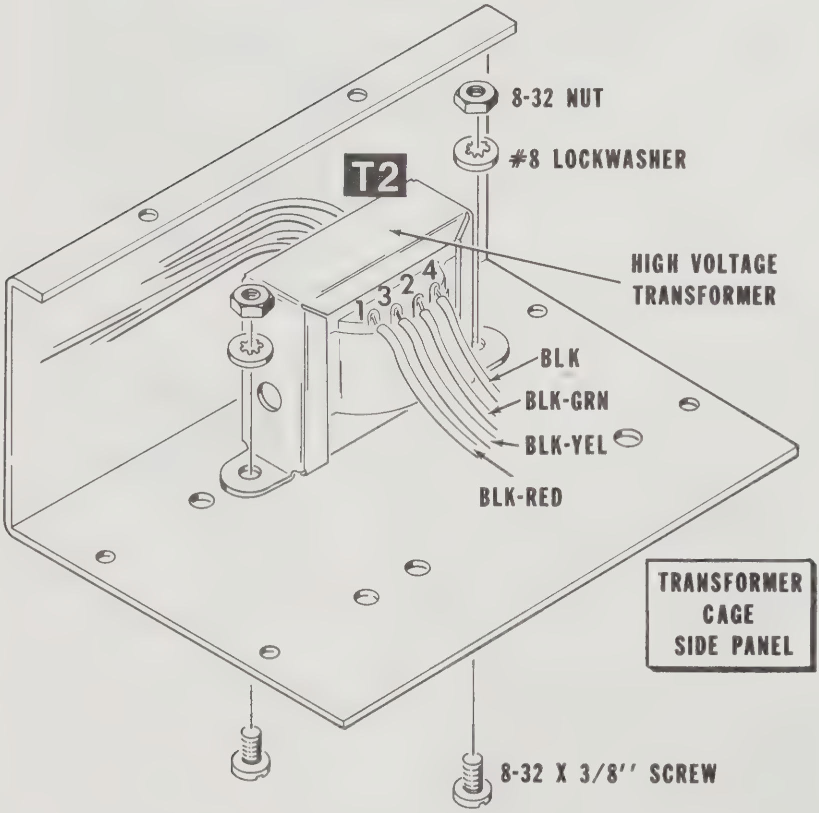
Refer to Pictorial 5-1 for the following steps.

( ) Refer to Detail 5-1A and cut the leads of the high voltage transformer (#54-282) as shown.

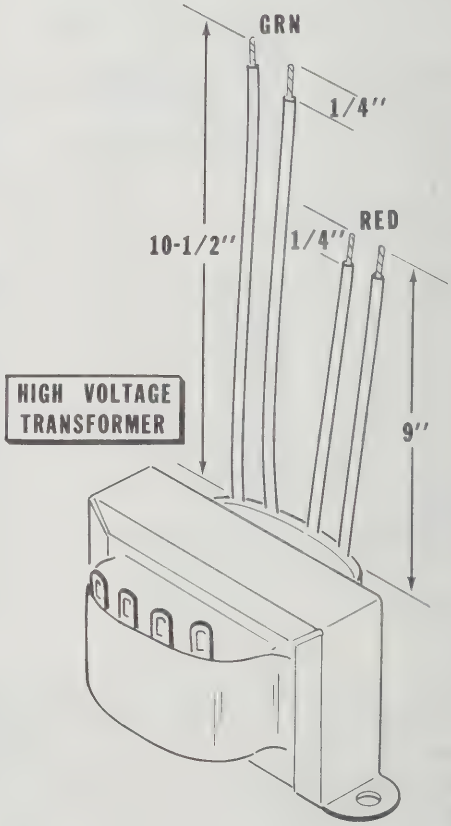
( ) Remove 1/4" of insulation from the end of each transformer lead.

( ) Locate one of the transformer cage side panels (#206-1161) and position it as shown. Both transformer cage side panels are the same and it makes no difference which one you use.

( ) Mount the transformer at T2 with two 8-32 × 3/8" screws, two #8 lockwashers, and two 8-32 nuts. Make sure that the transformer lugs are toward the open side of the transformer cage side panel.



PICTORIAL 5-1

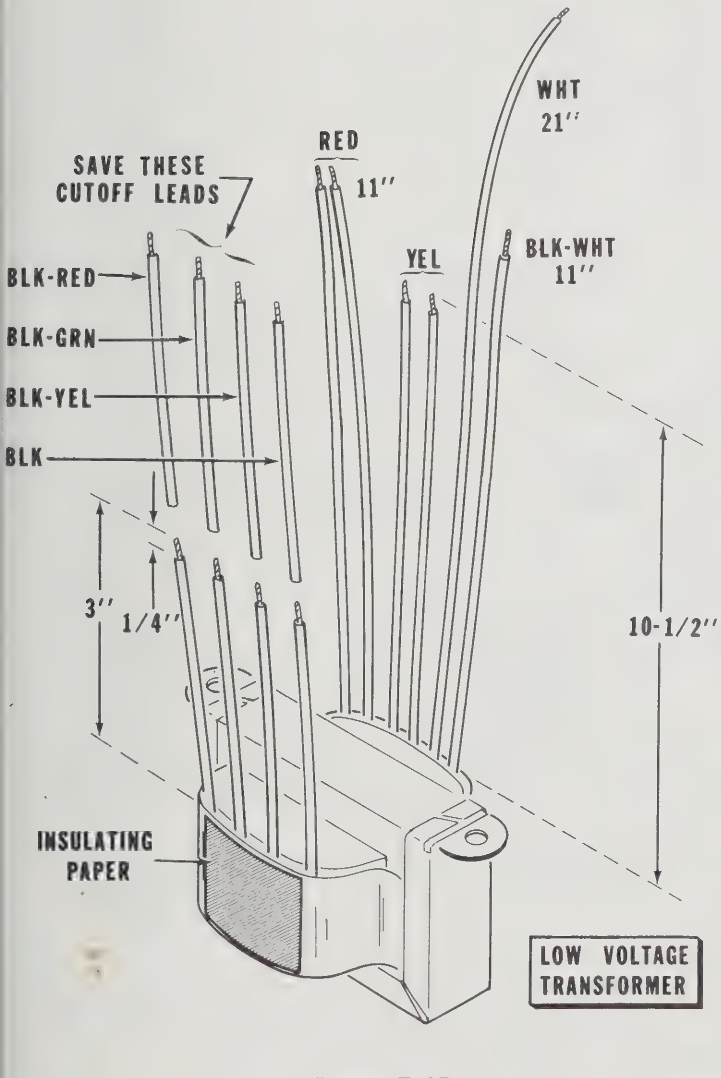


Detail 5-1A

☑ Refer to Detail 5-1B and cut the leads of the low voltage transformer (#54-880) to the lengths shown. NOTE: Save the cut-off black, black-red, black-yellow, and black-green leads. These leads will be used.

☑ Remove 1/4" of insulation from the end of each transformer lead.

☑ Remove the protective paper backing from the insulating paper. Then refer to Detail 5-1B and place the insulating paper over the metal shield on the transformer. Be sure to place the insulating paper on the side with the four short leads.

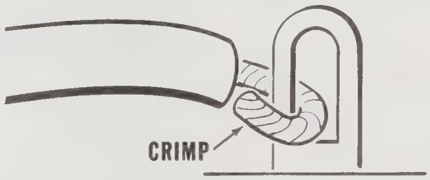


Detail 5-1B

☐ Prepare the four cut-off transformer leads as follows:

Black	8"
Black-green	8"
Black-red	7-1/2"
Black-yellow	8"

NOTE: In the following steps when you are instructed to make a connection mechanically secure, bend a hook in the end of the wire; then insert the hook through the lug and crimp and hook to the lug. See Detail 5-1C.



Detail 5-1C

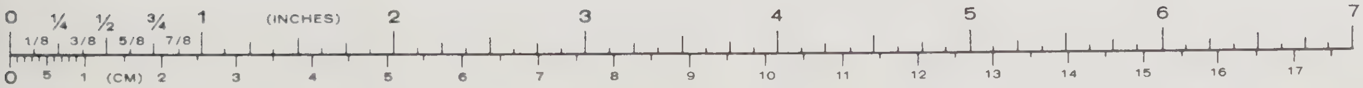
Connect the four prepared wires to the transformer lugs in the following steps. Make each of these wires mechanically secure, but do not solder the wires to the lugs at this time.

☑ Black wire to lug 4.

☑ Black-green wire to lug 2. NOTE: Lug 2 is next to lug 4.

☑ Black-yellow wire to lug 3.

☑ Black-red wire to lug 1.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Refer to Pictorial 5-2 for the following steps.

( ) Place the low voltage transformer into the cage so that the four short leads are toward the high voltage transformer. Do not mount the transformer at this time.

NOTE: In the following steps, (NS) means not to solder because other wires will be added later. (S-) with a number such as (S-2) means to solder the connection. The number after the "S" tells how many wires are in the connection.

Connect the four short leads coming from transformer T1 to the lugs of transformer T2 as follows. Make each of these connections mechanically secure.

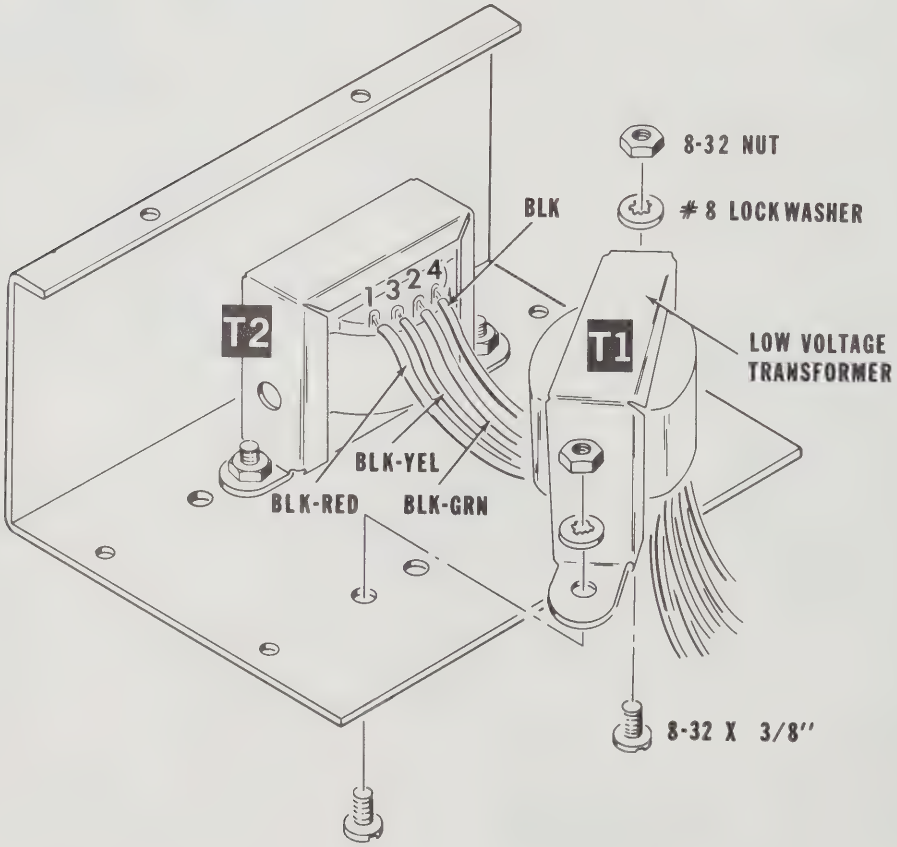
(✓) Black lead to lug 4 (S-2).

( ) Black-green lead to lug 2 (S-2). NOTE: Lug 2 is next to lug 4.

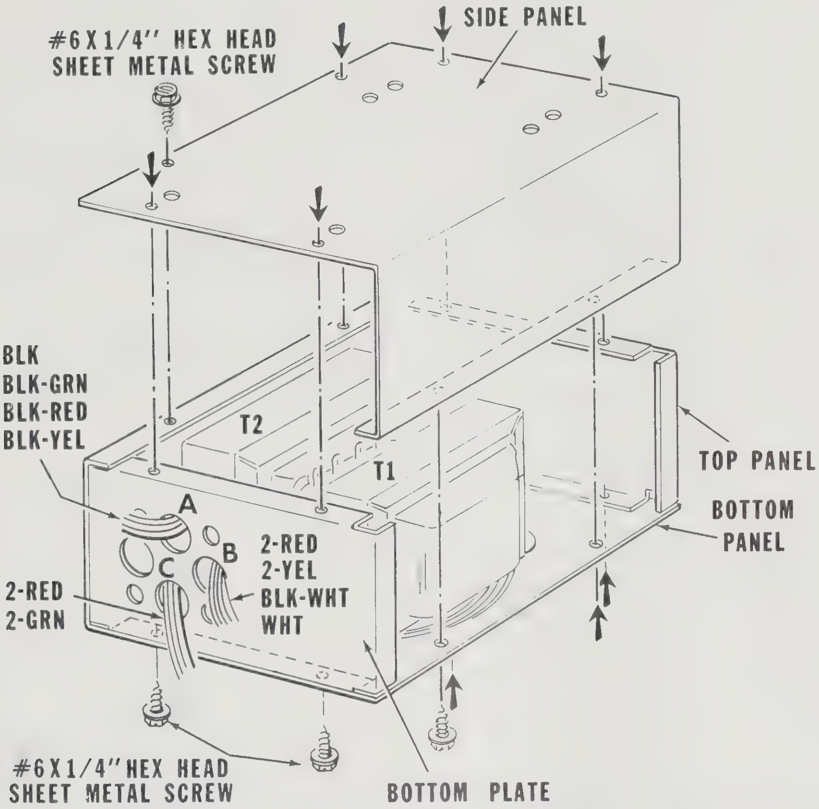
(✓) Black-yellow lead to lug 3 (S-2).

(✓) Black-red lead to lug 1 (S-2).

(✓) Mount the low voltage transformer with two 8-32 x 3/8" screws, two #8 lockwashers, and two 8-32 nuts.



PICTORIAL 5-2



PICTORIAL 5-3

Refer to Pictorial 5-3 for the following steps.

(✓) Locate the transformer cage bottom panel (#206-1162). This is the panel with the four press-in nuts.

(✓) Insert both red and both green leads from transformer T2 through hole C in the bottom panel.

(✓) Insert both red, both yellow, the white, and the black-white leads from transformer T1 through hole B in the bottom panel.

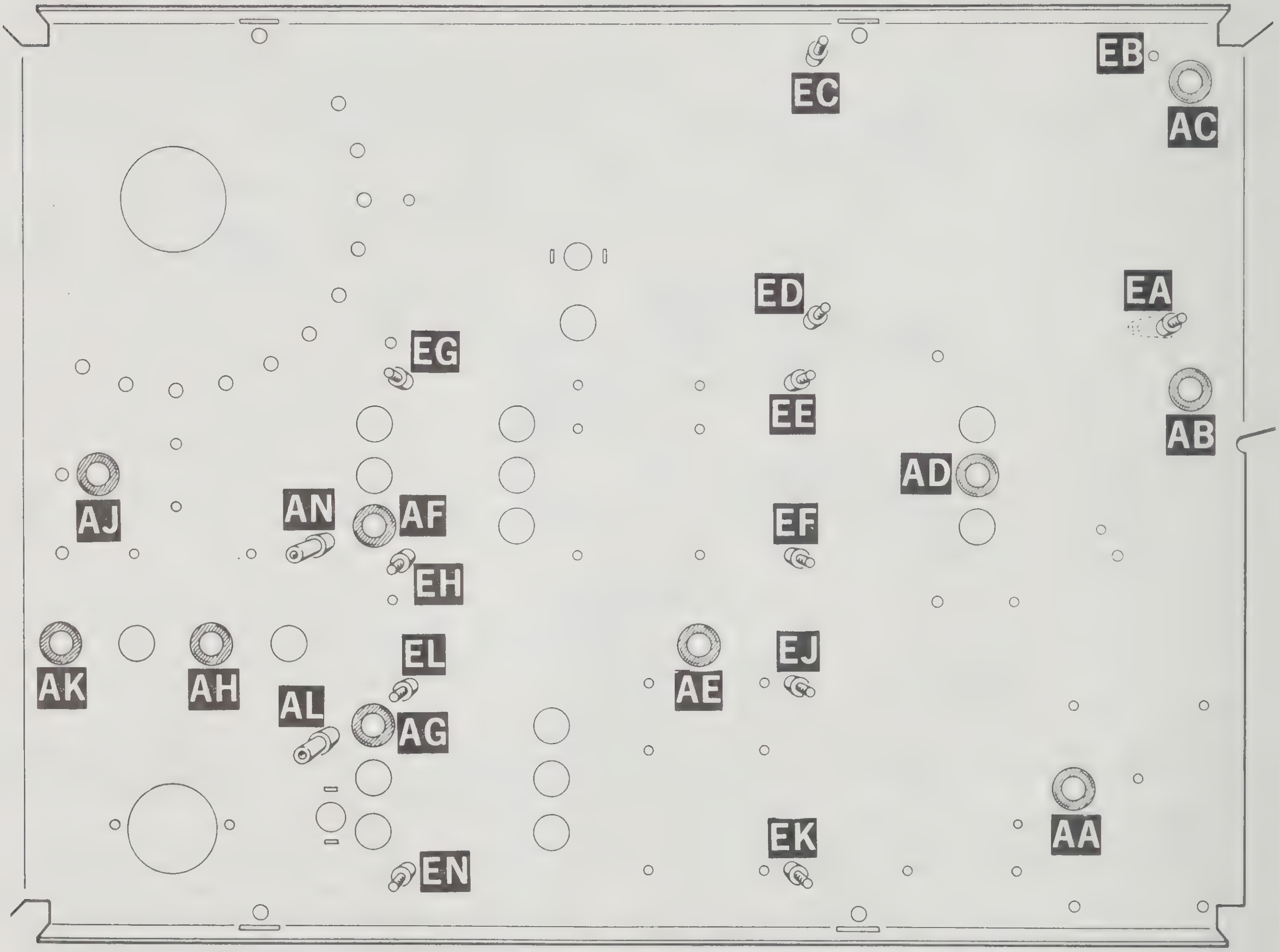
(✓) Insert the black, black-yellow, black-red, and black-green leads through hole A in the bottom panel.

(✓) Secure the bottom panel to the transformer cage side panel with two #6 x 1/4" hex head sheet metal screws.

(✓) In the same manner, mount the transformer cage top panel (#206-1171) to the other end of the transformer cage side panel. Position the four large holes in the top panel so that they are in line with the same holes in the bottom panel. Use two #6 x 1/4" hex head sheet metal screws.

(✓) Mount the other side panel to the transformer cage with eight #6 x 1/4" hex head sheet metal screws.

Lay the transformer cage aside, it will be used later.



PICTORIAL 6-1

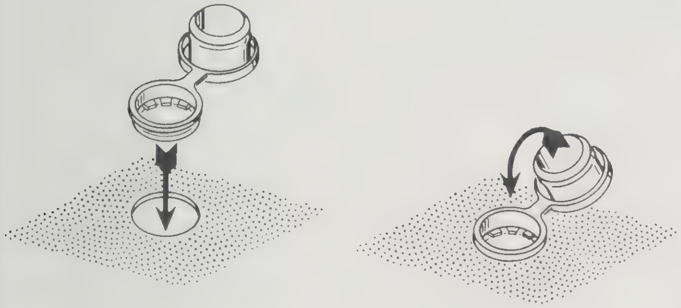
CHASSIS ASSEMBLY

(X) Remove the chassis identification drawing from the Illustration Booklet and hang it near your work area so that you can refer to it. This drawing shows the chassis from both sides and identifies the holes that will be used. NOTE: Not all of the holes in the chassis will be used.

Refer to Pictorial 6-1 for the following steps.

(X) Position the chassis as shown. This is the top side of the chassis. The upright part of the chassis to your right is the front.

(X) Refer to Detail 6-1A and install a plastic grommet in the chassis at AA.



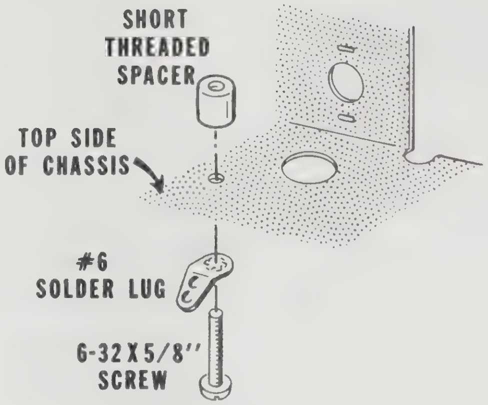
Detail 6-1A

In the same manner, install plastic grommets in the following chassis holes.

(X) AB
(X) AC
(X) AD
(X) AE
(X) AF
(X) AG
(X) AH
(X) AJ
(X) AK

(X) Locate eleven short, threaded spacers, eleven 6-32 x 5/8" screws, and a #6 solder lug. Use these in the following steps.

(X) Refer to Detail 6-1B and mount a spacer at EA using a screw and a #6 solder lug. Mount the solder lug on the under side of the chassis.



Detail 6-1B

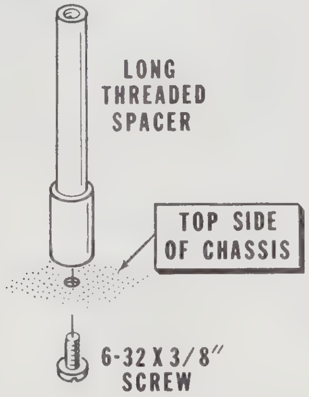
In the same manner, mount the remaining spacers at the following locations except without solder lugs.

( ) EF
( ) EC
(X) ED
(X) EE
(X) EK
(X) EG
(X) EH
(X) EJ
( ) EL
( ) EN

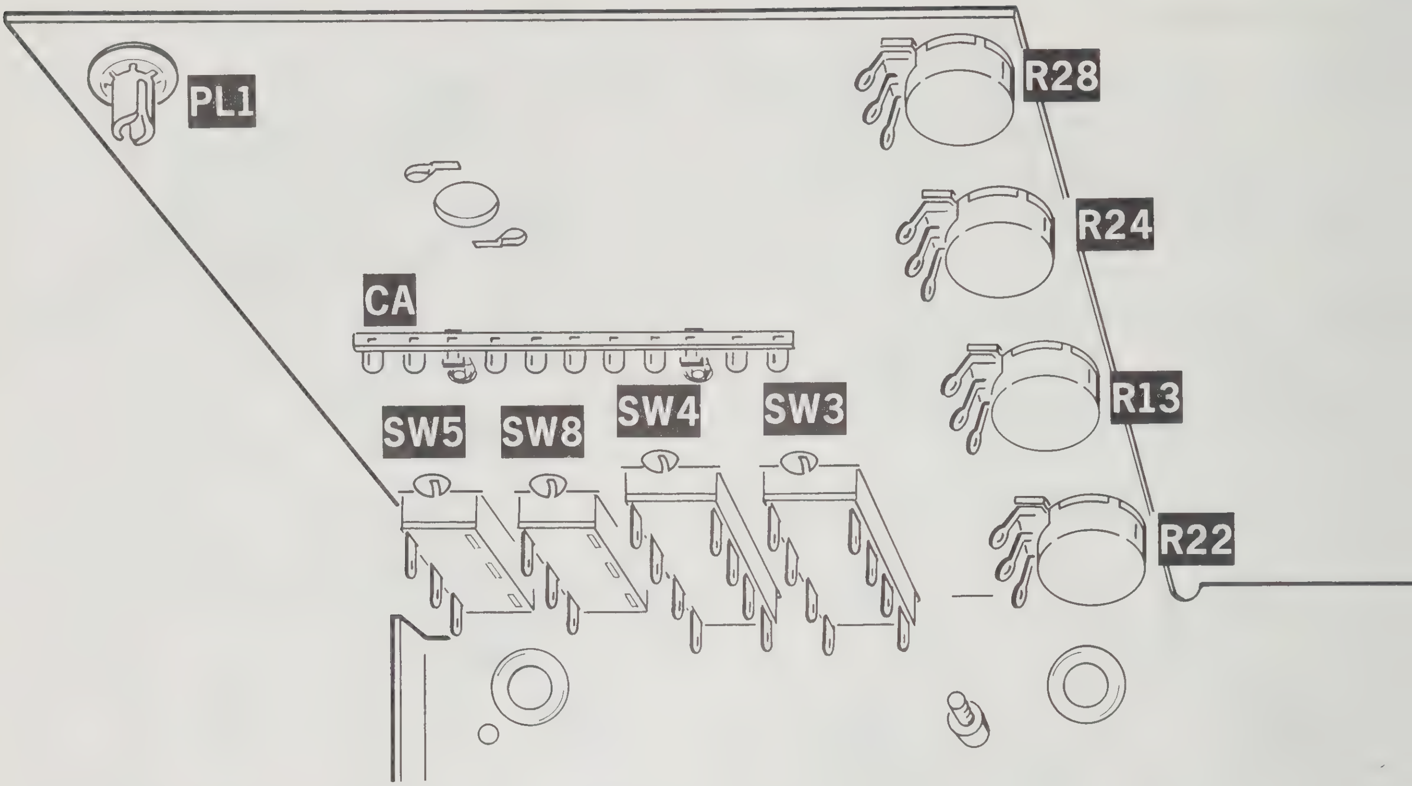
NOTE: Do not install a spacer at EB. This spacer will be installed later.

(X) Refer to Detail 6-1C and mount a long threaded spacer at AL with a 6-32 x 3/8" screw.

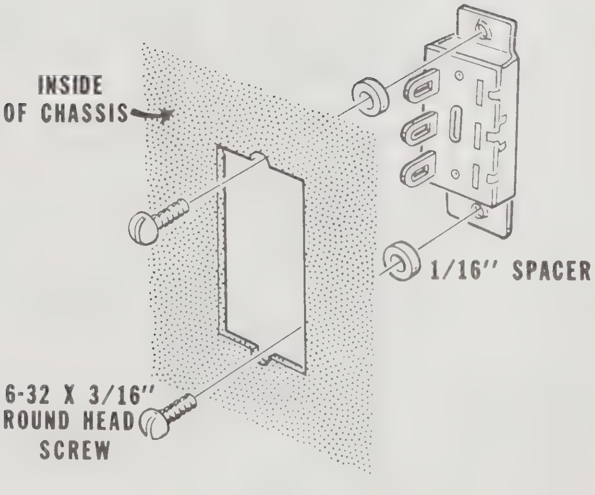
(X) In the same manner mount a long threaded spacer at AN with a 6-32 x 3/8" screw.



Detail 6-1C



PICTORIAL 6-2



Detail 6-2A

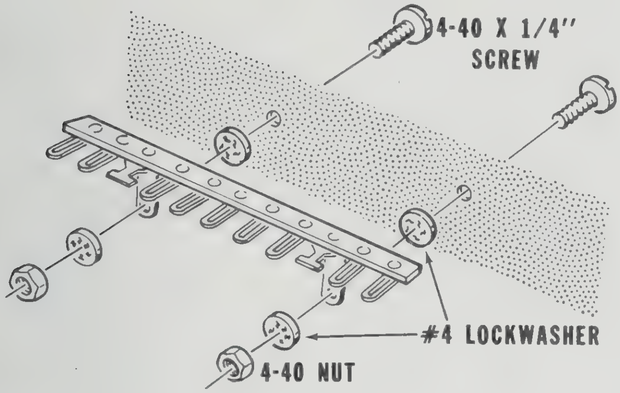
Refer to Pictorial 6-2 for the following steps.

(✓) SW5: Refer to Detail 6-2A and mount a 3-lug slide switch at SW5 with two 6-32 x 3/16" screws and two 1/16" spacers. Be sure to position the switch lugs as shown.

(✓) SW8: Mount a 3-lug slide switch at SW8 with two 6-32 x 3/16" screws and two 1/16" spacers. Be sure to position the switch lugs as shown.

(✓) SW4: Mount an 8-lug slide switch at SW4 with two 6-32 x 3/16" screws and two 1/16" spacers.

(✓) SW3: Mount an 8-lug slide switch at SW3 with two 6-32 x 3/16" screws and two 1/16" spacers.



Detail 6-2B

NOTE: Use the nut starter to hold and start 4-40 and 6-32 nuts on screws.

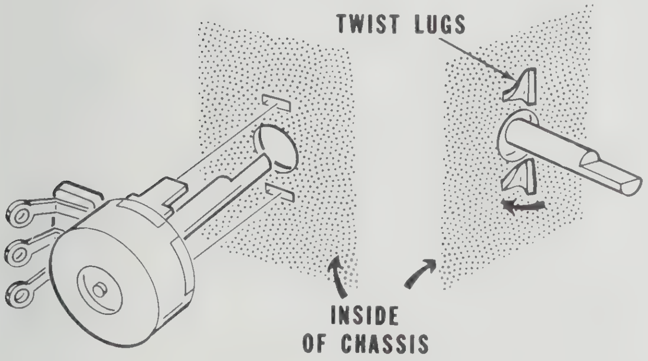
(X) Refer to Detail 6-2B and mount an 11-lug terminal strip at CA with two 4-40 x 1/4" screws, four #4 lockwashers, two 4-40 nuts.

(X) R22: Refer to Detail 6-2C and install a 1000 Ω (1 k) control (#10-1032) at R22.

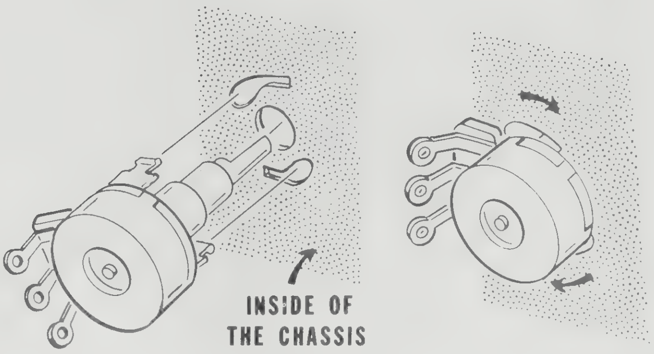
Install the next two controls in the same manner.

(X) R13: 10 kΩ control (#10-1031) at R13.

(X) R24: 1 MΩ (1 megohm) control (#10-1033) at R24.



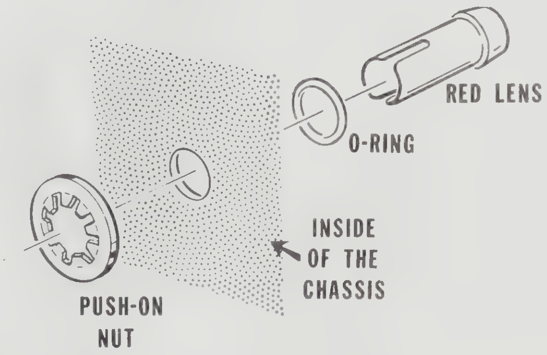
Detail 6-2C



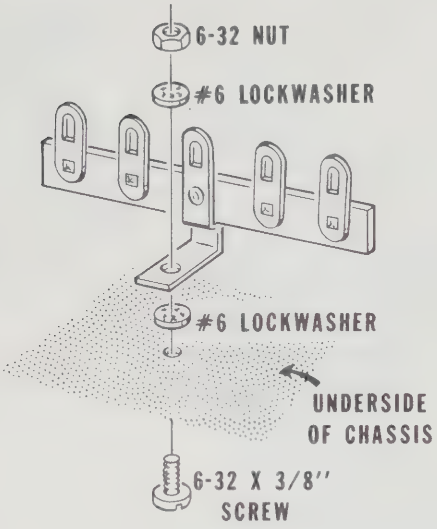
Detail 6-2D

(X) R28: Refer to Detail 6-2D and install a 25 kΩ control (#10-1024) at R28.

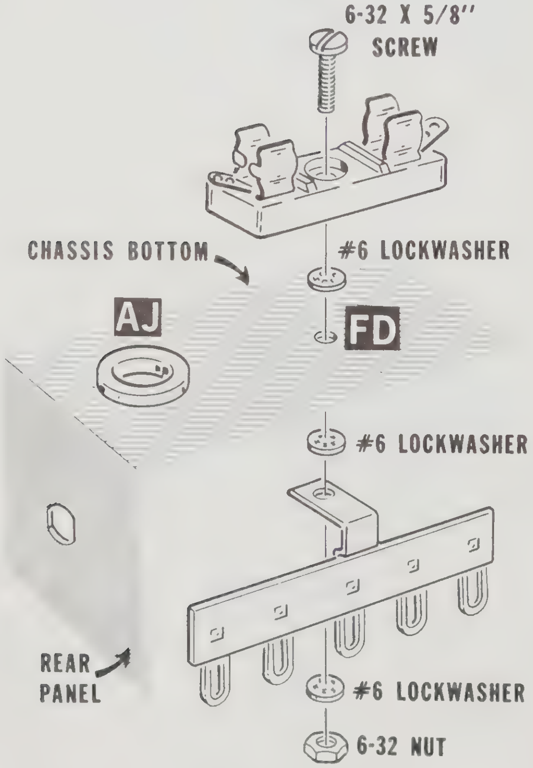
(X) Refer to Detail 6-2E and install the red lens in hole PL1 with a rubber O-ring and a push-on nut. Push the rubber O-ring onto the lens and then push the lens through the chassis. Position the push-on nut so that the hollow side of the nut faces the front panel.



Detail 6-2E



Detail 6-3A



Detail 6-3B

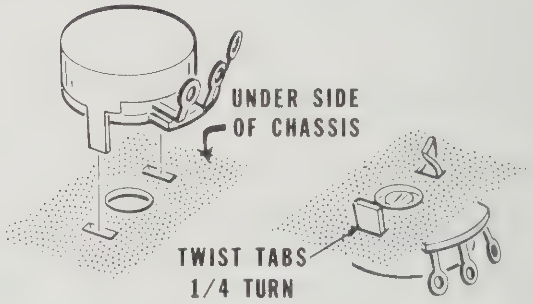
Refer to Pictorial 6-3 in the Illustration Booklet for the following steps.

(✓) Position the chassis bottom-side-up as shown. The following parts will be mounted on the back section of the chassis.

(✓) Refer to Detail 6-3A and mount a 5-lug terminal strip at FB. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut. Position the terminal strip as shown.

(✓) In the same manner, mount a 5-lug terminal strip at FC with a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut.

(✓) Refer to Detail 6-3B and mount a fuseholder at FD on the bottom of the chassis and a 5-lug terminal strip on the top of the chassis with 6-32 x 5/8" screw, three #6 lockwashers, and a 6-32 nut. Be sure to position the terminal strip and fuseholder as shown before you tighten the hardware.

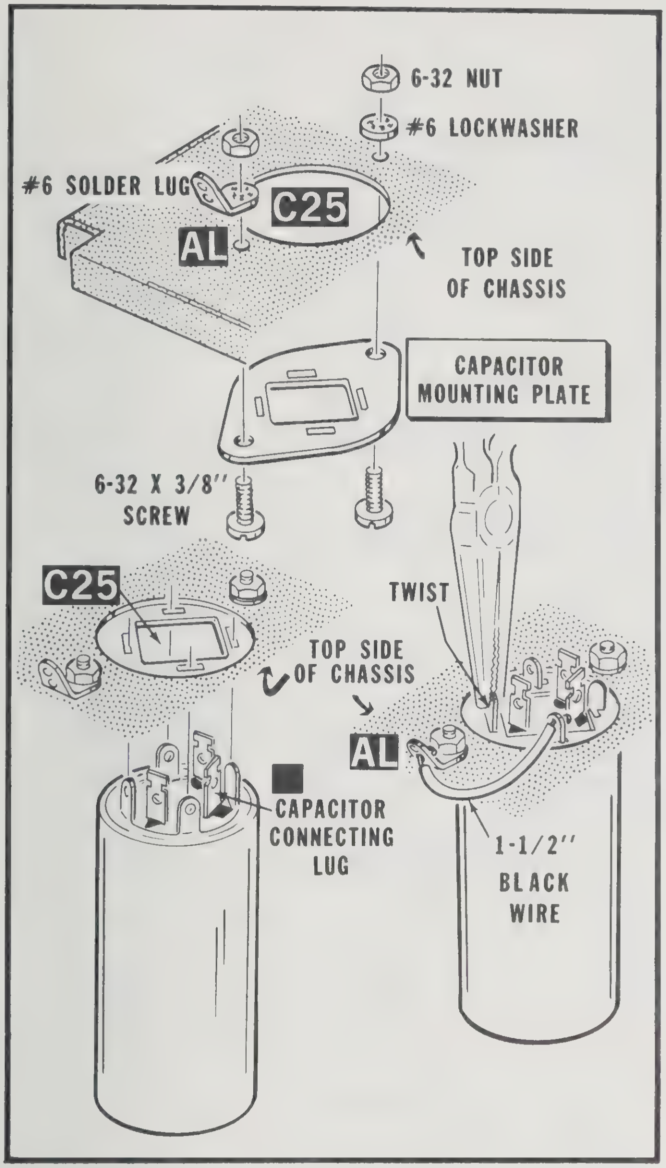


Detail 6-3C

(✓) R29: Refer to Detail 6-3C and install a 150 kΩ control (#10-282) at R29.

(✓) Refer to Detail 6-3D and mount a capacitor mounting plate at C25 with two 6-32 x 3/8" screws, a #6 lockwasher, a #6 solder lug, and two 6-32 nuts.

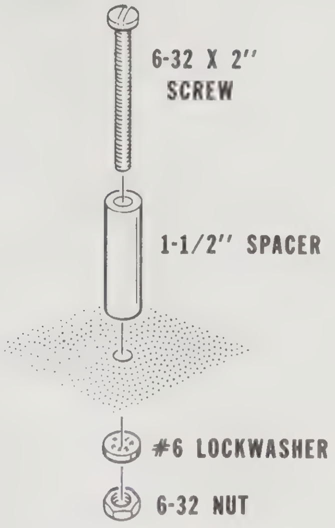
(✓) C25: Again refer to Detail 6-3D and install the 3-section electrolytic capacitor into the capacitor mounting plate. Be sure to position the capacitor lugs as shown.



Detail 6-3D

(X) Prepare a 1-1/2" black wire.

(X) Refer to Detail 6-3D and connect the 1-1/2" black wire between the lower hole in solder lug AL (S-1) and the indicated mounting lug of capacitor C25 (S-1). Be sure you do not connect this wire to a solder lug on capacitor C25 by mistake.



Detail 6-3E

(X) Refer to Detail 6-3E and install a 1-1/2" spacer at DD with a 6-32 x 2" screw, a #6 lockwasher, and a 6-32 nut. This spacer will act as a support so the chassis will not sit on the other parts during assembly.

(/) Mount a #8 solder lug at DX with an 8-32 x 3/8" screw and an 8-32 nut. Position the solder lug as shown and tighten the hardware securely. Then bend the solder lug away from the chassis.

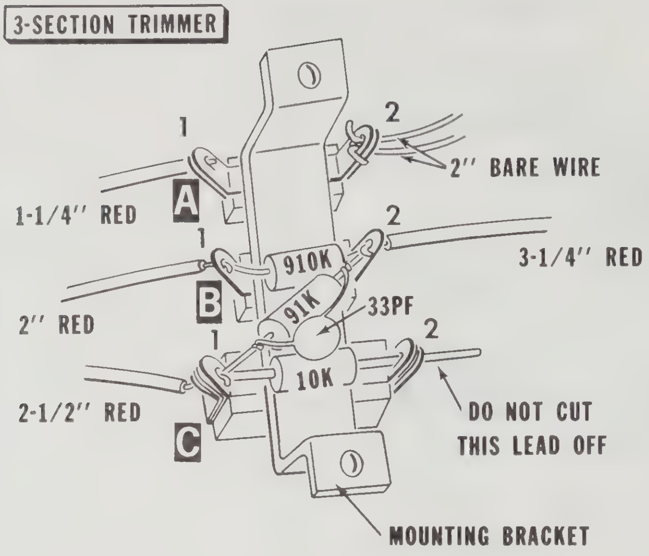
(X) Locate eight Speed Nuts. Note that each Speed Nut is flat on one side. Push the Speed Nuts onto the chassis with the flat side as shown at DE, DF, DP, DR, DS, DT, DY, and DZ.

(✓) Locate four 6-32 x 5/8" screws, and four short threaded spacers. Use these in the following steps.

Mount the screws and spacers at the following locations in the same manner as before.

(✓) DG	( ) DJ
( ) DH	(✓) DK

Set the chassis aside temporarily.



PICTORIAL 6-4

Refer to Pictorial 6-4 for the following steps.

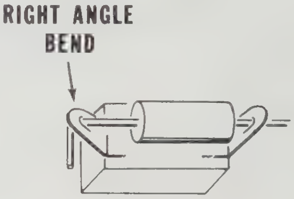
(X) Locate the following parts, these will be used in the following steps.

3-section trimmer
33 pF disc capacitor
10 kΩ (brown-black-orange) resistor
91 kΩ (white-brown-orange) resistor
910 kΩ (white-brown-yellow) resistor

(X) Turn the three trimmer screws in until they are snug. Do not overtighten the screws.

(X) Place the 3-section trimmer on your work surface as shown. Make sure that the largest section is positioned toward you.

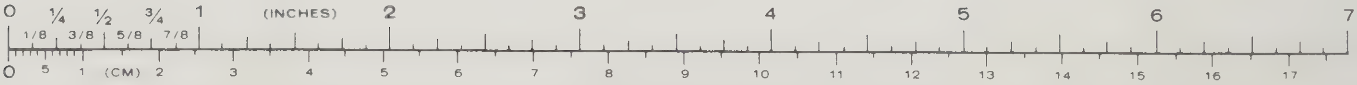
NOTE: Whenever you connect a component (resistor, capacitor, diode, etc.) to a lug, do not crimp the lead around the lug unless you are instructed to. It is important that lead lengths be kept as short and as neat as possible. Therefore, insert the lead straight through the lug and, after the lug has been soldered, cut off the excess lead lengths. If a lead will not stay in place, make a right-angle bend in the end of the lead and, after the lug is soldered, cut off the bend. See Detail 6-4A.

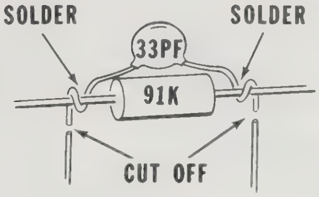


Detail 6-4A

(X) R3: Connect a 10 kΩ (brown-black-orange) resistor between section C lug 1 (NS) and lug 2 (S-1). NOTE: Do not cut off the lead protruding from lug 2.

Note that lugs 1 and 2 of section C are each composed of several leaves, one on top of another. Whenever you solder a lug like this, make sure that solder flows between all of the leaves, connecting them together. Check lug 2 of section C and resolder it if necessary.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 .5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



Detail 6-4B

☒ Refer to Detail 6-4B and solder the leads of a 33 pF disc capacitor to the leads of a 91 kΩ (white-brown-orange) resistor. Keep the capacitor close to the resistor, and solder the capacitor leads close to the resistor body.

☒ C3, R2: Connect the resistor-capacitor combination between section C lug 1 (NS) and section B lug 2 (NS). Make sure the 33 pF disc capacitor is laying flat against the 91 kΩ resistor so the trimmer will mount properly later.

☒ R1: Connect a 910 kΩ (white-brown-yellow) resistor between section B lug 1 (NS) and lug 2 (NS).

☒ Prepare the following red wires:

2-1/2"
2"
3-1/4"
1-1/4"

Connect one end of each prepared wire to a lug of the 3-section trimmer as follows:

☒ 2-1/2" red wire to section C lug 1 (S-3).

☒ 2" red wire to section B lug 1 (S-2).

☒ 3-1/4" red wire to section B lug 2 (S-3).

☒ 1-1/4" red wire to section A lug 1 (S-1).

☒ Connect two 2" bare wires to section A lug 2 (S-2).

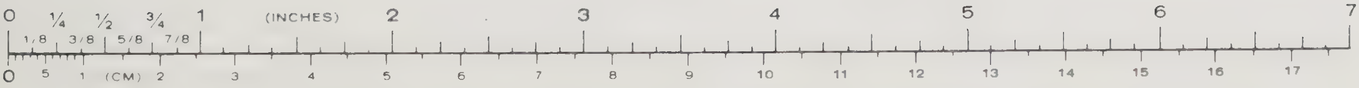
Trimmer Checkout

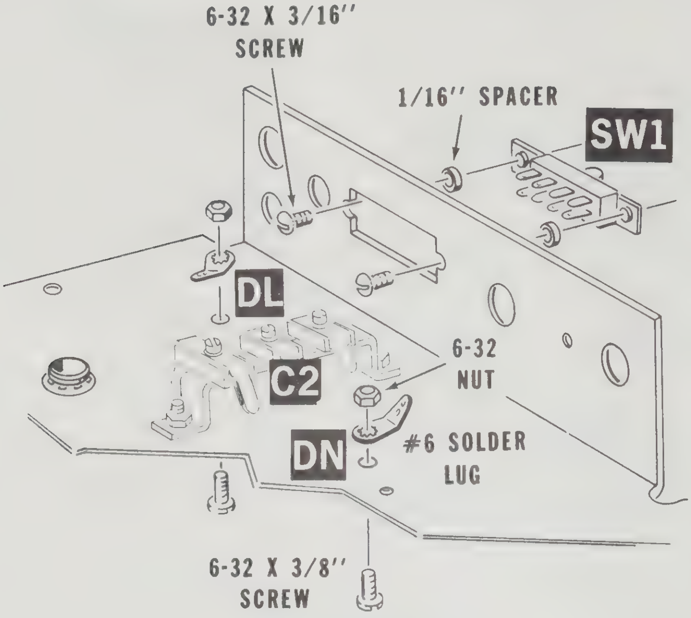
Carefully inspect the wiring on the 3-section trimmer for the following considerations.

☒ Where a trimmer lug is made up of more than one leaf, make sure that solder has flowed between all of the leaves to make a good connection. THIS IS IMPORTANT.

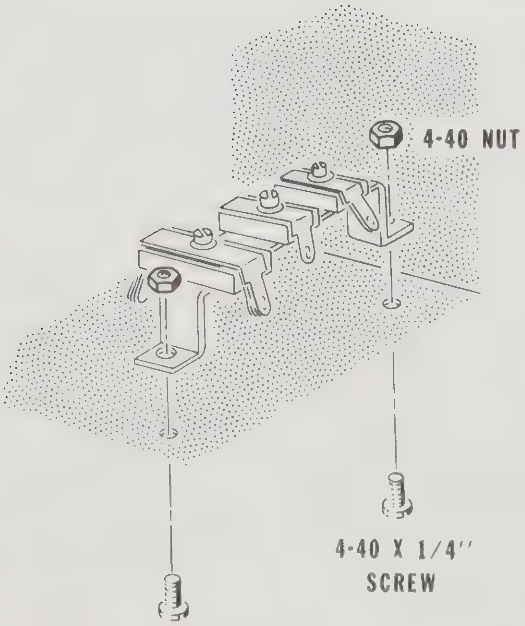
☒ Make sure that leads or wires do not touch the metal mounting bracket that the three trimmer sections are fastened to.

☒ Turn the trimmer over and set it on your work surface. Make sure that the two mounting feet (at the ends of the mounting bracket) set flat on the surface. If they do not, adjust the parts under the trimmer to allow the feet to set flat.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



PICTORIAL 6-5



Detail 6-5A

Chassis Assembly (cont'd.)

Refer to Pictorial 6-5 for the following steps.

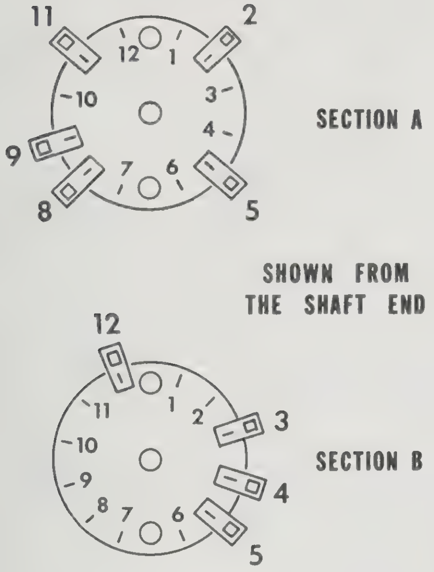
(✓) C2: Refer to Detail 6-5A and mount the 3-section trimmer at C2 with two 4-40 x 1/4" screws and two 4-40 nuts. Position the largest section away from the front of the chassis.

(✓) Mount a #6 solder lug at DL with a 6-32 x 3/8" screw and a 6-32 nut. Position the solder lug as shown and tighten the hardware securely.

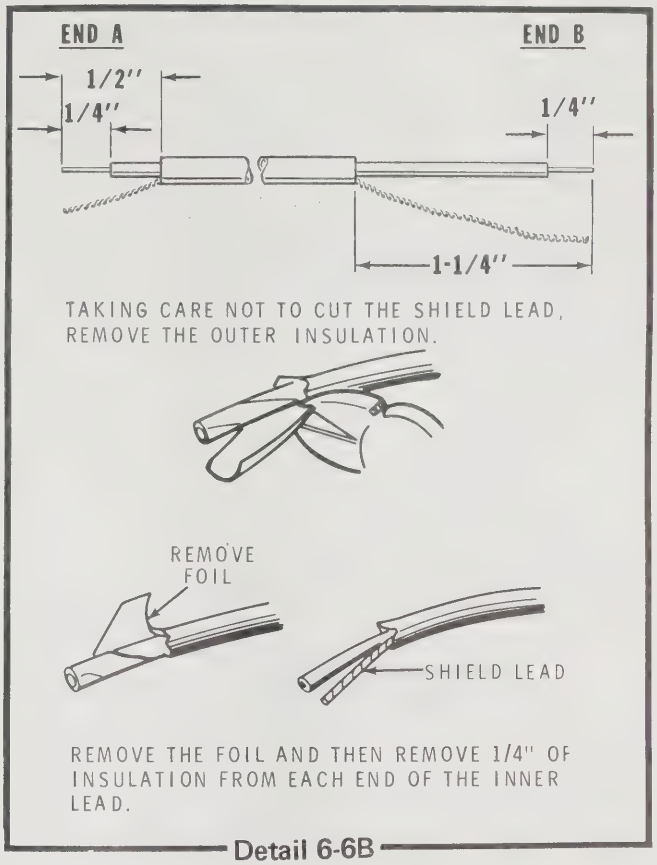
(✓) In the same manner mount a solder lug at DN with a 6-32 x 3/8" screw and a 6-32 nut. Position the solder lug as shown and tighten the hardware securely.

(✓) SW1: Mount an 8-lug slide switch at SW1 with two 6-32 x 3/16" screws and two 1/16" spacers.

Set the chassis aside temporarily.



Detail 6-6A



TAKING CARE NOT TO CUT THE SHIELD LEAD, REMOVE THE OUTER INSULATION.

REMOVE THE FOIL AND THEN REMOVE 1/4" OF INSULATION FROM EACH END OF THE INNER LEAD.

Detail 6-6B

Refer to Pictorial 6-6 for the following steps.

(X) Locate the two-section rotary switch/control (#63-1216). Position the switch on your work surface as shown.

( ) Refer to Detail 6-6A for lug identification. There are twelve possible lug positions on each wafer. However, there is not a lug at each position. Note that a lug position has a number assigned to it even if there is no lug.

(X) R6: Connect a 200 Ω (red-black-brown) resistor to section B between lugs 3 (NS) and 4 (NS). Leave the resistor leads long until after they are soldered. Then cut off the excess lead lengths.

(X) R5: Connect a 620 Ω (blue-red-brown) resistor to section B between lugs 4 (S-2) and 5 (NS).

(X) Prepare a 1-1/2" red wire. Connect this wire between section B lug 5 (S-2) and R4 lug 2 (S-1).

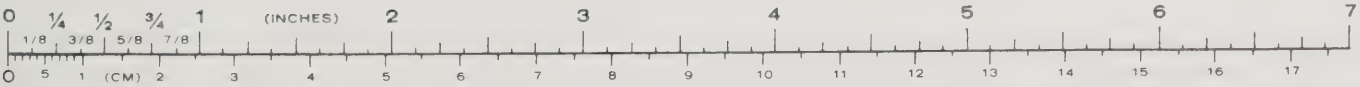
(X) Prepare an 8" red wire. Then connect one end of this wire to section A lug 11 (S-1).

(X) Refer to Detail 6-6B and prepare two 11" shielded cables.

(X) Connect the inner lead at end B of one of these shielded cables (refer to Detail 6-6B) to section B lug 12 (S-1). The shield lead will be connected later.

(X) Cut the shield lead off at end A of the other shielded cable. NOTE: Be sure you do not cut the shield lead off end B. Use this shielded cable in the next step.

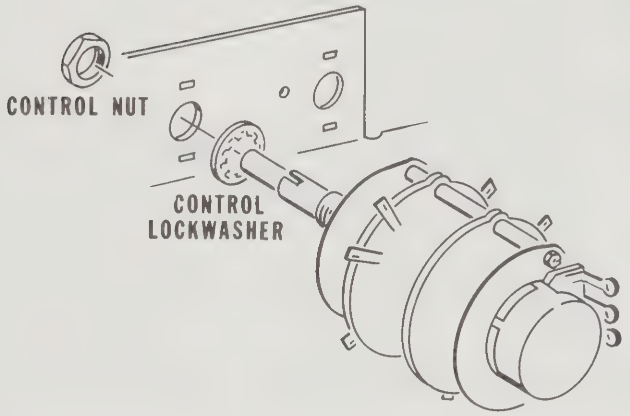
(X) Connect the inner lead at end B of the shielded cable to control R4 lug 3 (S-1). The shield lead will be connected later.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Refer to Pictorial 6-7 for the following steps.

( ) Locate the wires coming from trimmer C2, section A, lug 1; and from section B, lug 1; and bend them up. The wire coming from section C lug 1 should remain flat against the chassis.

( ) SW2, R4: Refer to Detail 6-7A and mount the 2-section rotary switch/control at SW2. Use a control lockwasher and a control nut. Be sure to position the control as shown.



Detail 6-7A

( ) Check the switch lugs that are closest to the chassis. Make sure that none of the lugs or their wires are touching the chassis.

( ) Connect the wire coming from trimmer C2, section A, lug 1, to rotary switch SW2, section A, lug 9 (S-1).

( ) Connect the wire coming from trimmer C2, section B, lug 1, to rotary switch SW2, section A, lug 8 (NS). Insert the wire through both tabs of this double lug. Route this wire as shown.

( ) Prepare a 3" red wire with 1/2" of insulation removed from one end and 1/4" of insulation removed from the other end.

( ) Insert the 1/2" bare end of this wire through switch SW1 lug 2 to lug 7. Solder both lugs.

( ) Connect the other end of this 3" red wire to switch SW2, section A, lug 8 (S-2). Insert the wire through both tabs of this double lug. Route this wire close to the panel as shown.

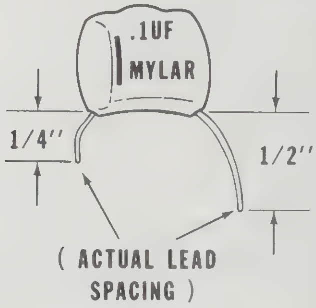
( ) Connect the bare wire coming from trimmer C2, section C, lug 2, to solder lug DL (NS).

( ) Connect one of the bare wires coming from trimmer C2, section A, lug 2, to solder lug DL (S-2). Route this under the red wire coming from section B lug 2.

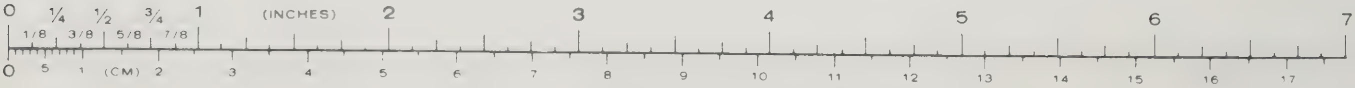
( ) Connect the other bare wire coming from trimmer C2, section A, lug 2, to switch SW1 lug 6 (S-1). Keep this wire as short as possible.

( ) Prepare a 3-1/4" red wire. Then connect one end of this wire to switch SW1 lug 4 (NS). Route this wire close to the panel as shown.

( ) Refer to Detail 6-7B and prepare the leads of a .1 μF Mylar capacitor. Bend the leads carefully so the capacitor will not be damaged inside.



Detail 6-7B



NOTE: In the next step, mount the capacitor close to the switch lugs, or the body of the capacitor will set up too high and interfere with later assembly.

(X) Install the prepared capacitor on switch SW1 as follows:

1. Insert the long lead through lug 4 to lug 8, and insert the short lead through lug 1. Solder all three lugs.
2. Make sure that the short capacitor lead through lug 1 is not touching lug 5.

(X) Locate the long red wire coming from rotary switch SW2. Route this wire around trimmer C2 and down through grommet AA. The other end of this wire will be connected later.

(X) Locate the wire coming from trimmer C2, section B, lug 2. Route this wire through rotary switch SW2 (near the center shaft) and connect it to section A lug 5 (S-1).

(X) Position the wire from the previous step down between trimmer C2 sections A and B.

(X) Locate the wire coming from trimmer C2, section C, lug 1. Connect this wire to rotary switch SW2, section A, lug 2 (S-1).

NOTE: In the next step, solder the shield leads to the lower hole in the solder lug. Do not get solder in the upper hole, as this will be used later.

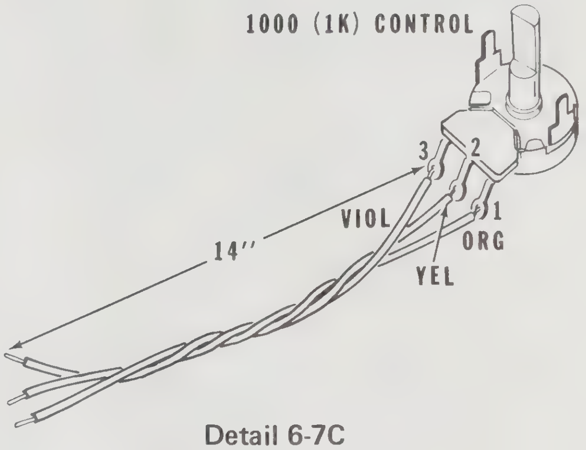
(X) Locate the shield leads of the shielded cables that are connected to rotary switch SW2 and control R4. Connect both of these shield leads to the lower hole in solder lug DN (S-2).

(X) Route both shielded cables down through grommet AA.

(X) R7: Connect a 200 Ω (red-black-brown) resistor between rotary switch SW2, section B, lug 3 (S-2) and solder lug DN (S-1). Use the upper hole in the solder lug.

(X) Prepare the following wires:

14"	yellow
14"	orange
14"	violet



Detail 6-7C

(X) Refer to Detail 6-7C and loosely twist the three prepared wires together to form a 3-wire twisted cable. Make sure that all three wires are even at the ends.

Again refer to Detail 6-7C and connect one end of the 3-wire twisted cable to a 1000 Ω (1 k) control (#10-1032) as follows:

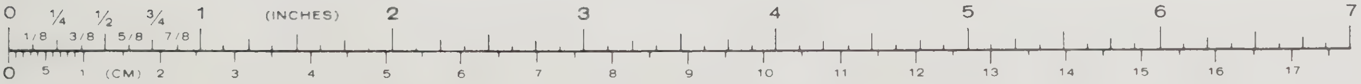
(X) Orange wire to lug 1 (S-1).

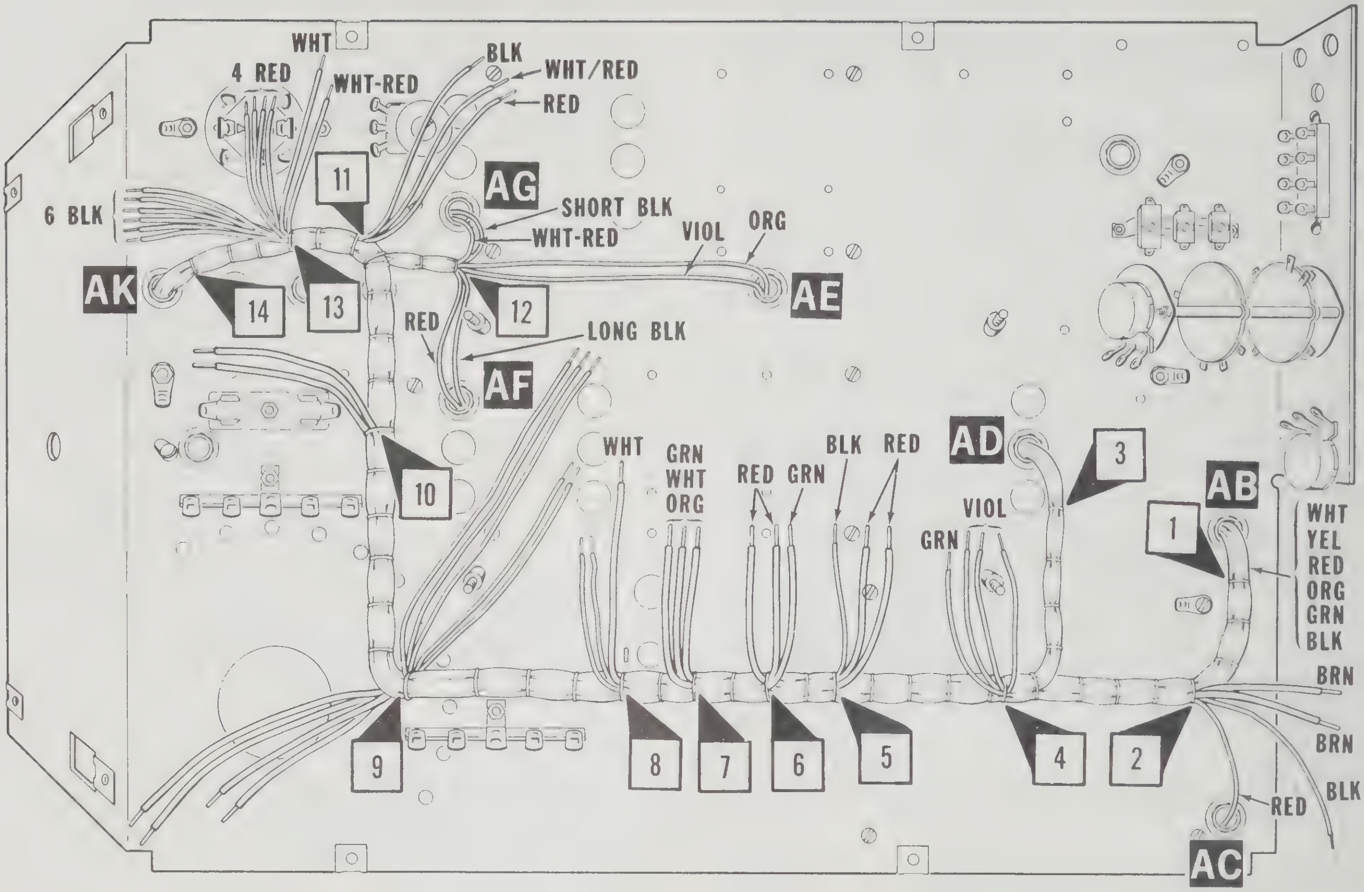
(X) Yellow wire to lug 2 (S-1).

(X) Violet wire to lug 3 (S-1).

(X) R8: Mount this control to the chassis front panel at R8. Insert the control shaft and tabs through the panel. Then twist the tabs to secure the control to the panel.

(X) Route the other end of the 3-wire twisted cable through grommet AE. Make sure this cable is routed around spacer DK as shown.





PICTORIAL 7-1

Refer to Pictorial 7-1 for the following steps.

This Pictorial identifies the various "breakouts" (a place where one or more wires come out of the harness). In the following steps, a harness wire will be called out only by its color and its BO# (breakout number). For example: Red wire from BO#3.

(✓) Place the wiring harness on the chassis with BO#1 toward the front.

( ) Insert all of the wires coming from BO#1 through grommet AB.

( ) Insert only the red wire coming from BO#2 through grommet AC.

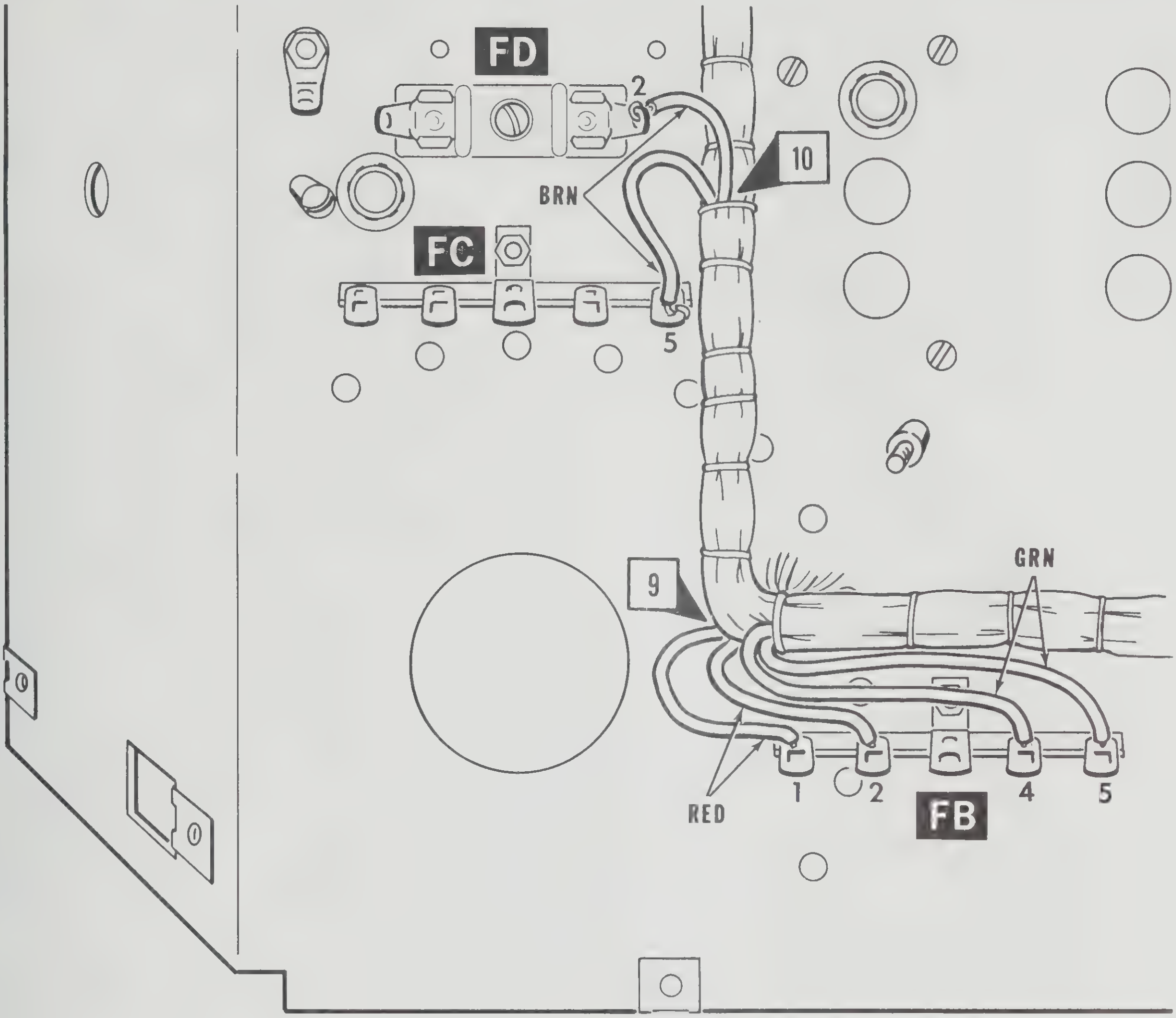
( ) Insert all of the wires coming from BO#3 through grommet AD.

( ) Insert only the orange and violet wires coming from BO#12 through grommet AE.

( ) Insert the longer of the two black wires and the red wire coming from BO#12 through grommet AF.

( ) Insert the shorter black and the white-red wires coming from BO#12 through grommet AG.

( ) Insert all of the wires coming from BO#14 through grommet AK.



PICTORIAL 7-2

Refer to Pictorial 7-2 for the following steps.

Connect the two large red and two large green wires coming from BO#9 to terminal strip FB as follows:

(✓) Either red wire to the lower hole in lug 1 (S-1).

(✓) Other red wire to the lower hole in lug 2 (S-1).

(✓) Either green wire to the lower hole in lug 4 (S-1). NOTE: Do not use lug 3.

(✓) Other green wire to the lower hole in lug 5 (S-1).

(✓) Connect either brown wire coming from BO#10 to terminal strip FC lug 5 (NS). Make this connection mechanically secure.

(✓) Connect the other brown wire coming from BO#10 to fuseholder FD lug 2 (S-1). Make this connection mechanically secure.

Refer to Pictorial 7-3 for the following steps.

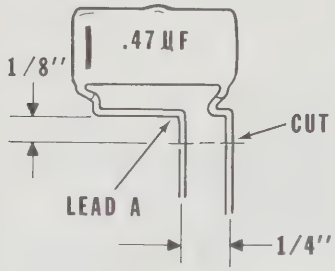
(✓) Position the chassis so that the rear of the chassis is toward you.

Connect the wires coming from BO#11 to control R29 as follows:

(✓) Black wire to lug 1 (NS).

(✓) White-red wire to lug 2 (NS).

(✓) Red wire to lug 3 (S-1).



Detail 7-3A

(✓) Prepare the leads of a .47 µF Mylar capacitor as follows. Refer to Detail 7-3A.

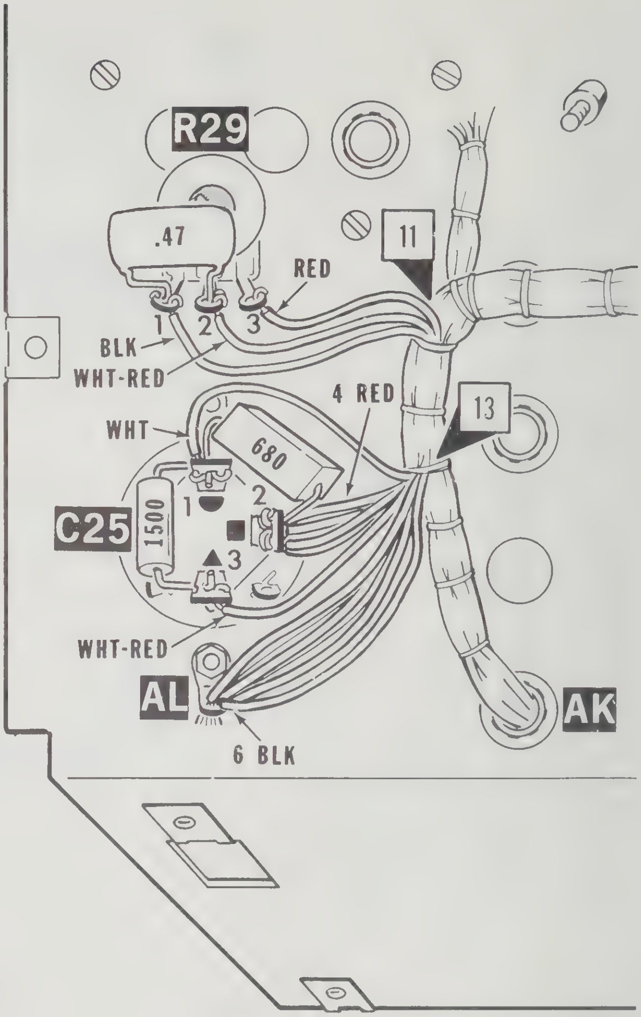
1. Bend either lead so that it is 1/4" from the other lead. This lead will be called "lead A."
2. Cut both leads so that they extend 1/8" beyond the bend in lead A.

(✓) Connect the prepared capacitor to control R29 between lugs 1 (S-2) and 2 (S-2).

(✓) Connect the six black wires coming from BO#13 to solder lug AL (S-6). Make sure that all six wires are securely soldered.

(✓) Connect the four red wires coming from BO#13 to capacitor C25 lug 2 (NS).

(✓) Connect the white-red wire coming from BO#13 to capacitor C25 lug 3 (NS).



PICTORIAL 7-3

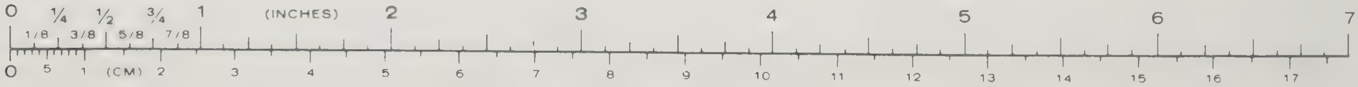
(✓) Connect the white wire coming from BO#13 to capacitor C25 lug 1 (NS).

(✓) Connect a 1500 Ω (brown-green-red) 2-watt resistor to capacitor C25 between lugs 1 (NS) and 3 (S-2). Keep the resistor leads short. Make sure the resistor leads do not touch the mounting lugs of C25.

(✓) Connect a 680 Ω, 5-watt resistor to capacitor C25 between lugs 1 (S-3) and 2 (S-5). Keep the leads short.

(✓) Carefully check the wires connected to lug 2. Make sure each wire is securely soldered.

(✓) Make sure that none of the leads or wires from one lug is touching any part of the chassis or another lug.



BELL & HOWELL SCHOOLS

July 23, 1975

IMPORTANT NOTICE

Please make the following changes in your Oscilloscope Manual before you begin to assemble your kit.

Schematic Diagram – Lower right corner, in reference to the line cord.

Change the words "Ribbed Lead" to "Black."

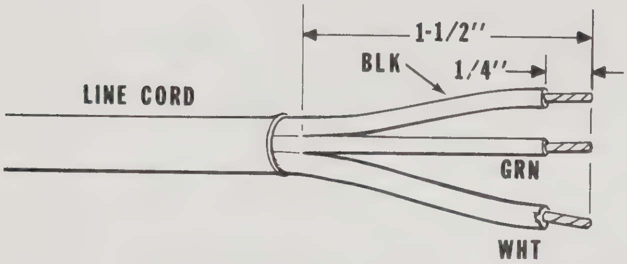
Add the words "White" to the line cord lead that is connected to the fuse.

Illustration Booklet – Remove Pictorial 7-4 from this Notice and tape it over Pictorial 7-4 in your Illustration Booklet.

Page 81 – Remove Page 81 from this Notice and tape it over Page 81 in your Manual.

Thank you,

HEATH COMPANY



Detail 7-4A

Refer to Pictorial 7-4 for the following steps.

( ) Refer to Detail 7-4A and prepare the line cord as follows:

1. Remove the outer insulation of the line cord for 1-1/2".
2. Twist together the fine wire strands at the end of each lead and apply a small amount of solder to hold them in place.

( ) Locate the line cord strain relief and install it on the line cord 4" from the end as shown in Detail 7-4B. Then install the strain relief in hole AN.

( ) Route the line cord end through grommet AJ as shown in Pictorial 7-4.

( ) Connect the white line cord lead to terminal strip FC lug 1 (NS). Make this connection mechanically secure.

( ) Connect the black line cord lead to fuseholder FD lug 1 (S-1). Make this connection mechanically secure.

( ) Connect the green line cord lead to solder lug DX (S-1). Make this connection mechanically secure.

( ) Locate the grommet plate, and install three plastic grommets in the plate. It makes no difference which holes you use.

( ) Set the prewired transformer cage under the chassis and route the wires coming from the cage up through the large hole in the chassis.

( ) Position the grommet plate so the hole without a grommet is facing the rear of the chassis. Then route the wires coming from the transformer cage through the grommets as follows:

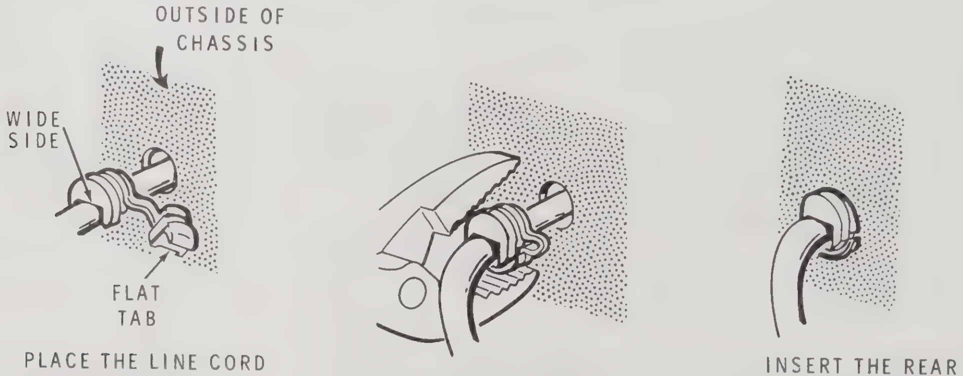
( ) Black-green, black-yellow, black-red, and black through grommet A.

( ) Black-white, both red, both yellow, and the long white wire through grommet B. NOTE: There are two pairs of red wires coming from the transformer cage. Make sure that you use the pair coming from hole B in this step.

( ) Both red and both green wires through grommet C.

( ) Mount the grommet plate to the transformer cage with four 8-32 x 3/8" screws. Leave these screws just loose enough so that the cage can be rotated.

( ) Locate the "Danger High Voltage" label and remove the protective paper backing. Then affix the label to the chassis as shown.

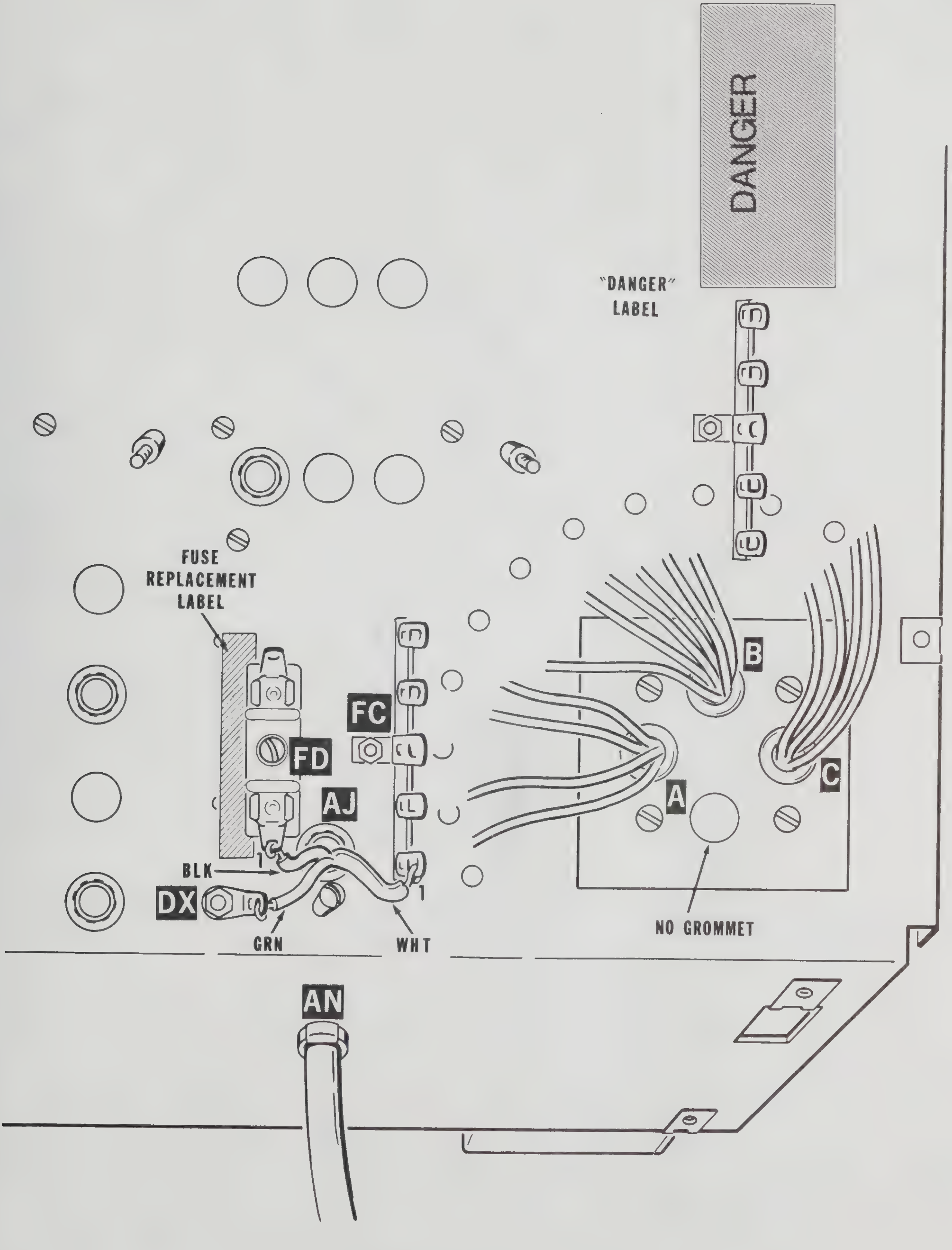


PLACE THE LINE CORD STRAIN RELIEF OVER THE CABLE.

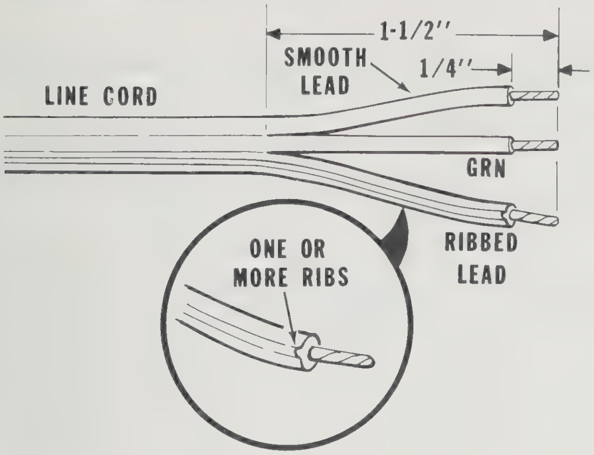
SQUEEZE THE TWO SEGMENTS TOGETHER.

INSERT THE REAR HALF INTO THE CHASSIS HOLE.

Detail 7-4B



PICTORIAL 7-4



Detail 7-4A

Refer to Pictorial 7-4 for the following steps.

( ) Refer to Detail 7-4A and prepare the line cord as follows:

1. Separate the leads at the end of the line cord for 1-1/2".
2. Twist together the fine wire strands at the end of each lead and apply a small amount of solder to hold them in place.
3. Note that one line cord lead is ribbed and the other lead is smooth.

( ) Locate the line cord strain relief and install it on the line cord 4" from the end as shown in Detail 7-4B. Then install the strain relief in hole AN. Make sure that the ribbed line cord lead is toward the transformer cage side of the chassis as shown.

( ) Route the line cord end through grommet AJ as shown in Pictorial 7-4.

( ) Connect the ribbed line cord lead to terminal strip FC lug 1 (NS). Make this connection mechanically secure.

( ) Connect the smooth line cord lead to fuseholder FD lug 1 (S-1). Make this connection mechanically secure.

( ) Connect the green line cord lead to solder lug DX (S-1). Make this connection mechanically secure.

( ) Locate the grommet plate, and install three plastic grommets in the plate. It makes no difference which holes you use.

( ) Set the prewired transformer cage under the chassis and route the wires coming from the cage up through the large hole in the chassis.

( ) Position the grommet plate so the hole without a grommet is facing the rear of the chassis. Then route the wires coming from the transformer cage through the grommets as follows:

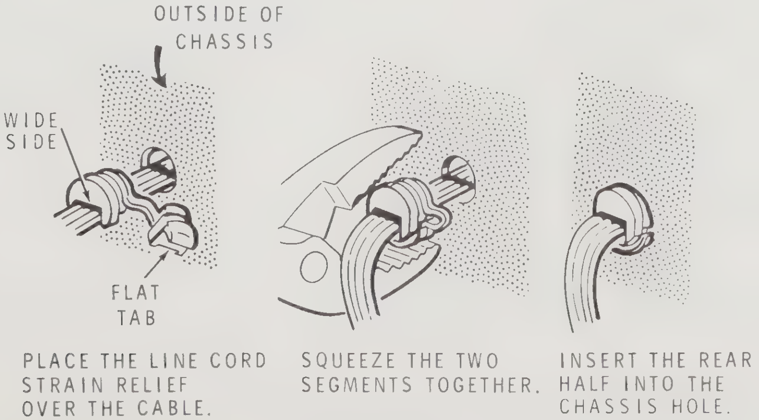
( ) Black-green, black-yellow, black-red, and black through grommet A.

( ) Black-white, both red, both yellow, and the long white wire through grommet B. NOTE: There are two pairs of red wires coming from the transformer cage. Make sure that you use the pair coming from hole B in this step.

( ) Both red and both green wires through grommet C.

( ) Mount the grommet plate to the transformer cage with four 8-32 x 3/8" screws. Leave these screws just loose enough so that the cage can be rotated.

( ) Locate the "Danger High Voltage" label and remove the protective paper backing. Then affix the label to the chassis as shown.


OUTSIDE OF CHASSIS
WIDE SIDE
FLAT TAB
PLACE THE LINE CORD STRAIN RELIEF OVER THE CABLE.
SQUEEZE THE TWO SEGMENTS TOGETHER.
INSERT THE REAR HALF INTO THE CHASSIS HOLE.

Detail 7-4B

Refer to Pictorial 7-5 in the Illustration Booklet for the following steps.

Connect the wires coming from grommet C to terminal strip FB as follows:

(✓) Either red wire to lug 1 (S-1).

(✓) Other red wire to lug 2 (S-1).

(✓) Either green wire to lug 4 (S-1). NOTE: Do not use lug 3.

(✓) Other green wire to lug 5 (S-1).

(✓) Connect the black-white wire coming from grommet B to terminal strip FC lug 3 (S-1).

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions follow, one for 120 VAC line voltage and the other for 240 VAC line voltage. In the United States 120 VAC is most often used, while in other countries 240 VAC is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

120 Volt AC Wiring

Refer to Detail 7-5A for the following steps.

Connect the wires coming from grommet A to terminal strip FC as follows. Make all of the connections mechanically secure.

(✓) Black wire to lug 1 (NS).

(✓) Black-green wire to lug 2 (NS).

(✓) Black-yellow wire to lug 4 (NS).

(✓) Black-red wire to lug 5 (NS).

(✓) Connect a 1" bare wire to terminal strip FC between lugs 1 (S-3) and 2 (S-2). Make these connections mechanically secure.

(✓) Connect a 1" bare wire to terminal strip FC between lugs 4 (S-2) and 5 (S-3). Make these connections mechanically secure.

(✓) Install the 1/4-ampere fuse in the fuseholder.

240 Volt AC Wiring

Refer to Detail 7-5B for the following steps.

Connect the wires coming from grommet A to terminal strip FC as follows. Make all of the connections mechanically secure.

( ) Black wire to lug 1 (S-2).

( ) Black-green wire to lug 2 (NS).

( ) Black-yellow wire to lug 4 (NS).

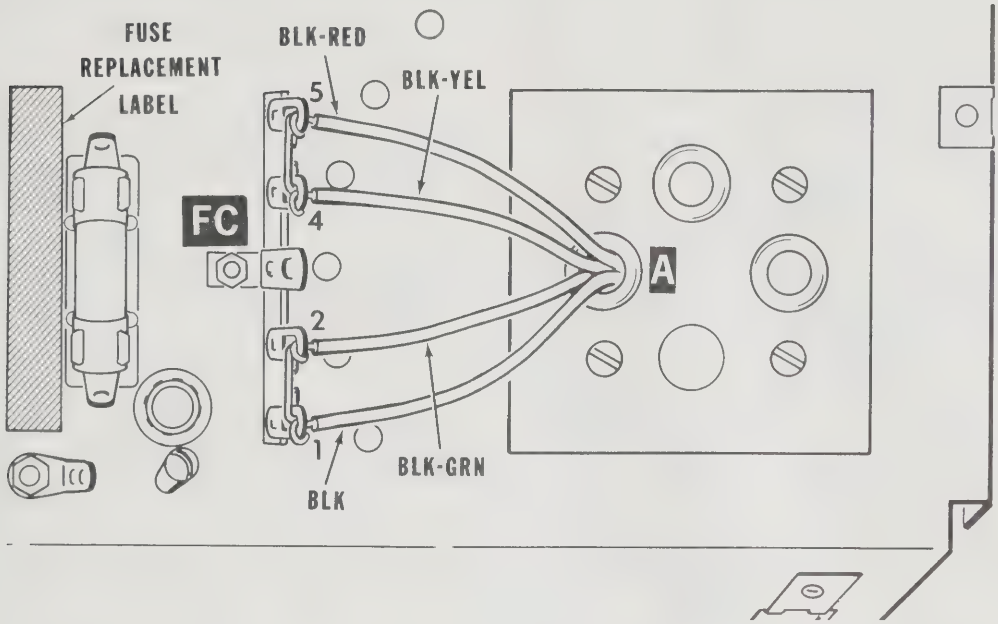
( ) Black-red wire to lug 5 (S-2).

( ) Connect a 1-1/2" black wire to terminal strip FC between lugs 2 (S-2) and 4 (S-2). Make these connections mechanically secure.

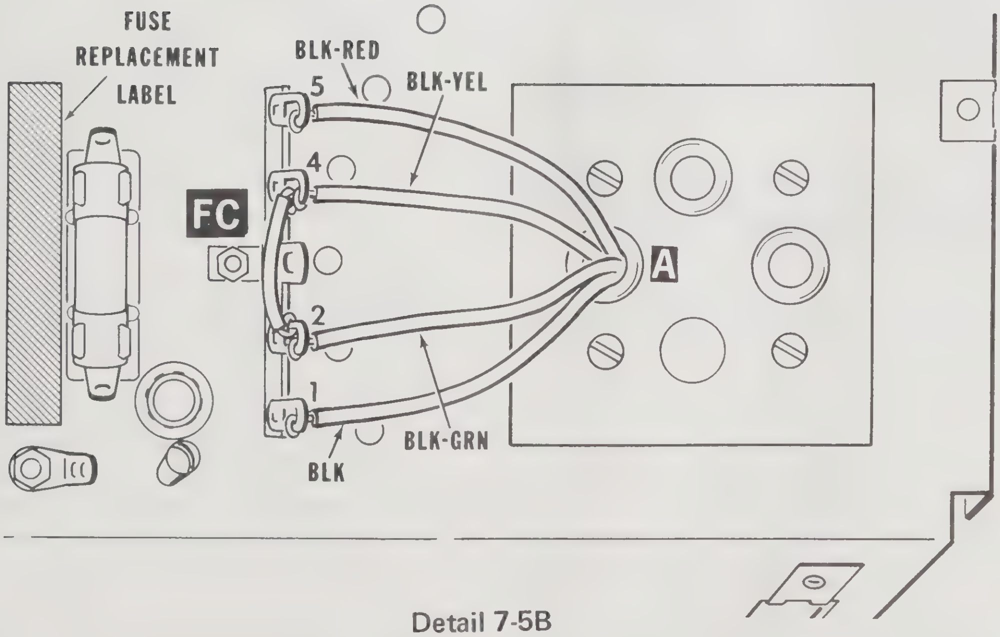
( ) Install the 1/8-ampere fuse in the fuseholder.

(✓) Locate the fuse replacement label and write your fuse size on the label. If you are wiring this oscilloscope to operate from 120 volts AC, write "1/4 ampere slow-blow" in the space provided. If you are wiring this oscilloscope to operate from 240 volts AC, write "1/8 ampere slow-blow" in the space provided.

(✓) Remove the protective paper backing and affix the label to the chassis along side the fuseholder.



Detail 7-5A



Detail 7-5B

0 1/4 1/2 3/4 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Refer to Pictorial 8-1 for the following steps.

(X) Position the chassis right-side-up with the rear of the chassis toward you. Then place the input shield (#206-1169) under the left side of the chassis to support it.

(X) R23: Cut both leads of a 3.3 MΩ, 1-watt (orange-orange-green) resistor to 1/4". Then bend one lead at a right angle to the resistor body.

(X) Connect this 3.3 MΩ resistor between control R24 lug 3 (S-1) and terminal strip CA hole 9 (S-1). NOTE: Do not use lug 9.

(X) Cut both leads of a 100 Ω (brown-black-brown) resistor to 1/2".

(X) R11: Connect the 100 Ω resistor between switch SW3 lug 1 (NS) and terminal strip CA hole 8 (S-1).

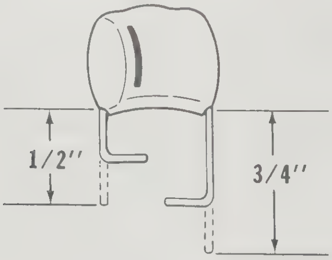
(X) Cut both leads of a 2200 Ω (red-red-red) resistor to 1/2".

(X) R9: Connect the 2200 Ω resistor between switch SW3 lug 1 (S-2) and terminal strip CA lug 9 (NS).

(X) Cut off any excess lead lengths from these last two resistors.

(X) Connect a 1" bare wire from switch SW4 lug 6, through switch SW3 lug 2, to SW3 lug 7. Solder lugs 2 and 7 on switch SW3, but not lug 6 on SW4.

(X) Refer to Detail 8-1A and prepare the leads of a .1 μF Mylar capacitor as shown.

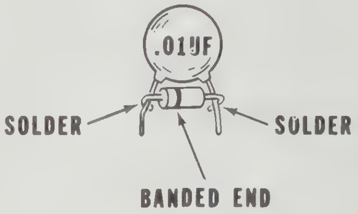


Detail 8-1A

(X) C6: Connect the prepared capacitor to switch SW4 between lugs 1 (NS) and 6 (S-2). Position the capacitor against the front panel under terminal strip CA.

(X) Cut both leads of a 100 kΩ (brown-black-yellow) resistor to 1/2". Then bend one lead at a right angle to the resistor body.

(X) R12: Connect the 100 kΩ resistor between switch SW4, lug 1 (S-2) and terminal strip CA lug 4 (NS).



Detail 8-1B

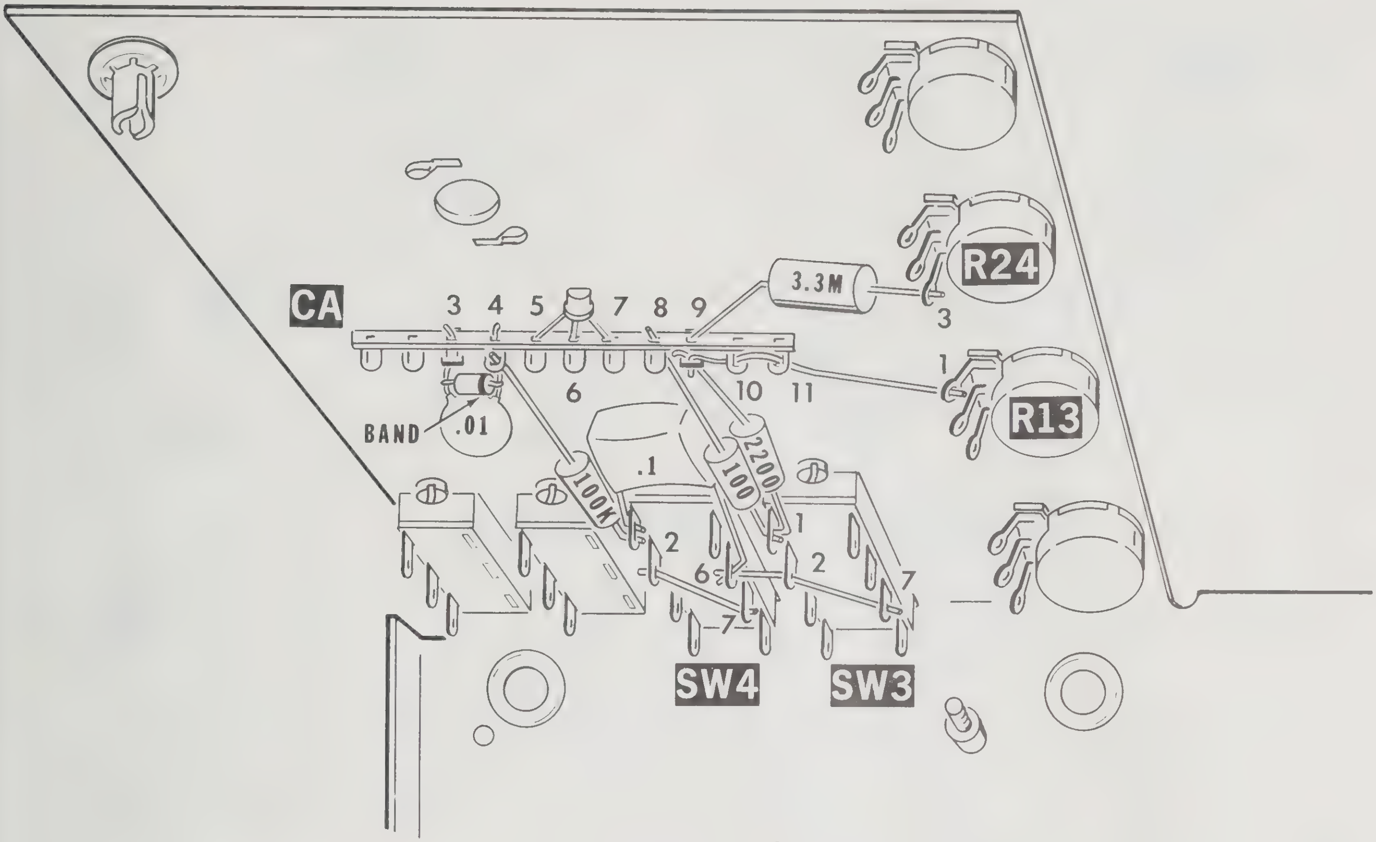
(X) Locate a 1N4149 diode (#56-56) and a .01 μF disc capacitor. Then refer to Detail 8-1B and prepare a diode-capacitor combination as follows:

1. Cut both leads of the diode and the capacitor to 1/2".
2. Solder the diode leads to the capacitor leads close to the capacitor body.

NOTE: In the next step, install the diode-capacitor combination under the terminal strip. Be sure to use the holes in the terminal strip and not the lugs.

(X) D1, C7: Connect the diode-capacitor combination to terminal strip CA between holes 3 (S-1) and 4 (S-1). Be sure to position the banded end of the diode toward hole 4. NOTE: It is alright if the unbanded lead of the diode touches the terminal strip mounting screw.

NOTE: In the next step, be sure to install the transistor so its flat surface faces the panel. Also be sure to use the holes in the terminal strip and not the lugs.



PICTORIAL 8-1

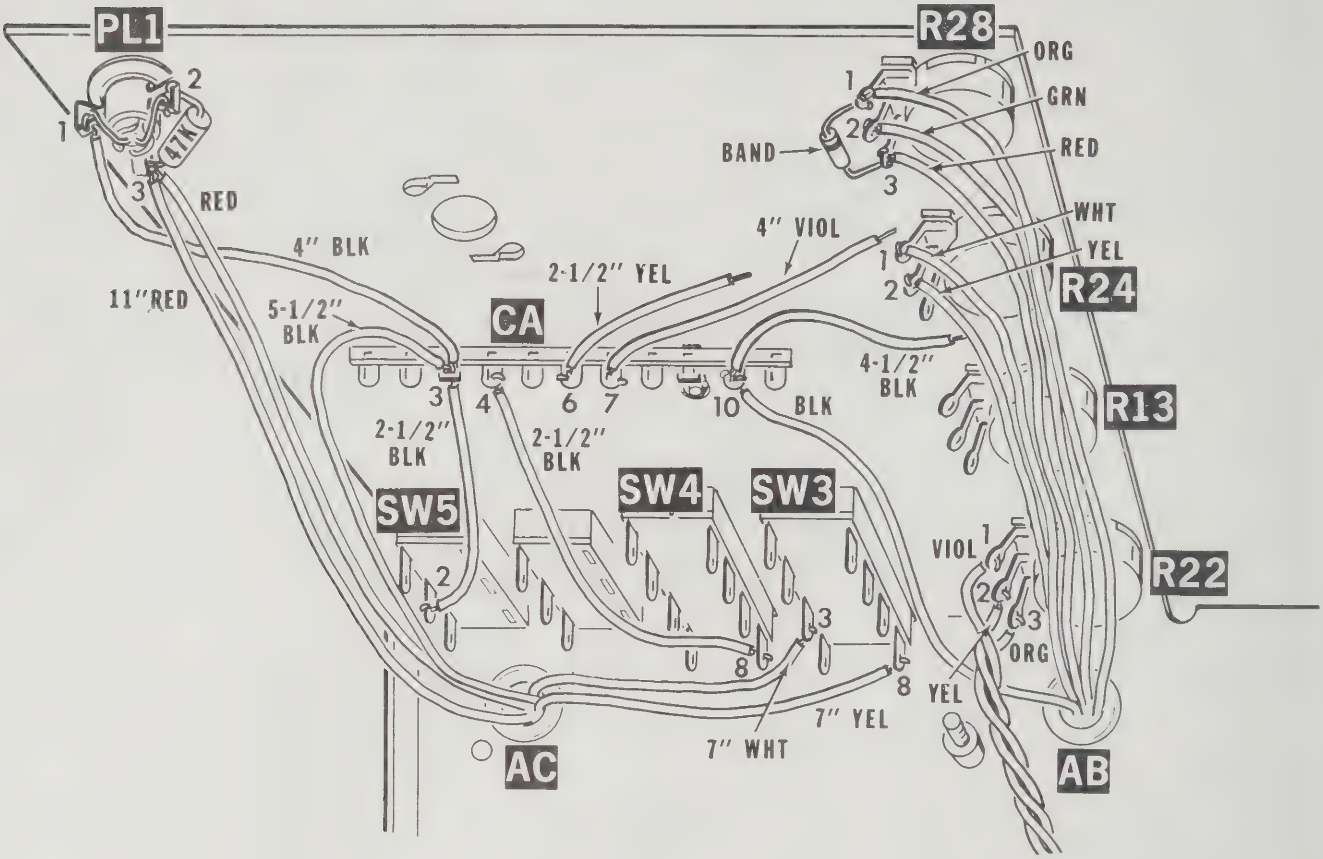
(✓) Install an X29A829 transistor (#417-201) as shown on terminal strip CA between holes 5 (S-1), 6 (S-1), and 7 (S-1). Insert the leads into the holes only as far as is needed to be soldered.

(✓) Connect a 1" bare wire to switch SW4 between lugs 2 (S-1) and 7 (NS). Cut off the excess wire length.

Connect a 1-1/4" bare wire between terminal strip CA lugs 9, 10, and 11, and control R13 lug 1 as follows:

1. (✓) Insert the bare wire down through terminal strip CA lug 11 and solder the end of the wire to control R13 lug 1.

2. (✓) Insert the other end of this bare wire down through terminal strip CA lug 10 and crimp the wire around lug 9. Solder lug 9 but not the other two lugs.



PICTORIAL 8-2

Refer to Pictorial 8-2 for the following steps.

Connect the wires coming from grommet AB as follows:

(✓) Black wire to terminal strip CA, lug 10 (NS). Position this wire close to the front panel.

(✓) Yellow wire to control R24 lug 2 (S-1).

(✓) White wire to control R24 lug 1 (S-1).

(✓) Red wire to control R28 lug 3 (NS).

(✓) Green wire to control R28 lug 2 (S-1).

(✓) Orange wire to control R28 lug 1 (NS).

(✓) Connect a VR-9.1 zener diode (#56-19) to control R28 between lugs 1 (S-2) and 3 (S-2). Be sure to connect the banded end of the diode to lug 1. Position the diode so that it is not touching lug 2.

(✓) Prepare the following wires:

8-1/2" violet
8-1/2" yellow
8-1/2" orange

(✓) Twist these three wires together to form a 3-wire twisted cable.

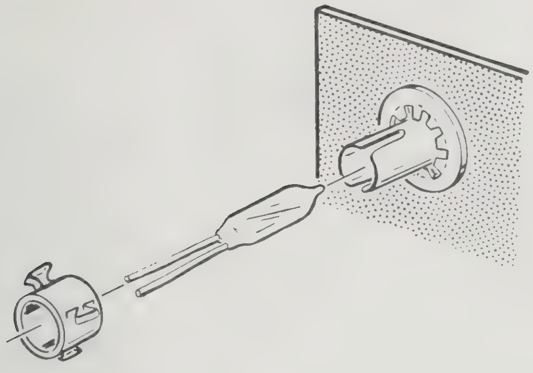
Connect the wires at one end of this 3-wire twisted cable to control R22 as follows:

(✓) Orange wire to lug 3 (S-1).

(✓) Yellow wire to lug 2 (S-1).

(✓) Violet wire to lug 1 (S-1).

The other end of this cable will be connected later.



Detail 8-2A

Refer to Detail 8-2A for the next two steps.

(X) PL1: Insert the neon lamp into the red lens at PL1.

(X) Slide the terminal collar over the red lens. Position the collar so that the lugs are positioned as shown.

(X) Connect the neon lamp leads to terminal collar PL1 lugs 1 (S-1) and 2 (S-1). Wrap the leads around the outside of the lugs and apply a very small amount of solder to the outside of the lugs. Do not get solder in the hole in the lug.

(X) Connect a 47 kΩ (yellow-violet-orange) resistor to terminal collar PL1 between lugs 2 (S-1) and 3 (NS). Position the resistor close to the terminal collar.

(X) Prepare the following wires:

2-1/2" black
4" black
5-1/2" black
11" red
2-1/2" black
7" white
7" yellow
2-1/2" yellow
4" violet
4-1/2" black

NOTE: In the following steps, many of the wires are longer than is needed to reach their connecting points so they can be positioned close to the chassis. In each step, refer to the Pictorial and route the wire as shown.

( ) Connect a 2-1/2" black wire between switch SW5 lug 2 (S-1) and terminal strip CA lug 3 (NS).

( ) Connect a 4" black wire between terminal strip CA lug 3 (NS) and terminal collar PL1 lug 1 (S-1).

( ) Connect a 5-1/2" black wire to terminal strip CA lug 3 (S-3). Route the other end of this wire down through grommet AC.

( ) Connect the red wire coming from grommet AC to terminal collar PL1 lug 3 (NS).

( ) Connect one end of an 11" red wire to terminal collar PL1 lug 3 (S-3). Route the other end of this wire down through grommet AC.

( ) Connect a 2-1/2" black wire between switch SW4 lug 8 (S-1) and terminal strip CA lug 4 (S-2).

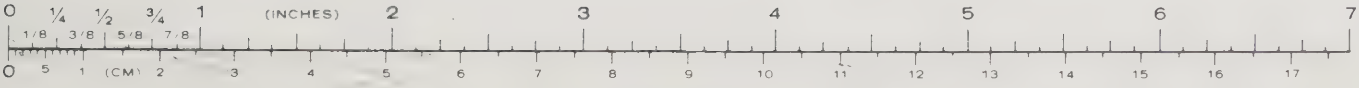
( ) Connect one end of a 7" white wire to switch SW3 lug 3 (S-1). Route the other end of this wire down through grommet AC.

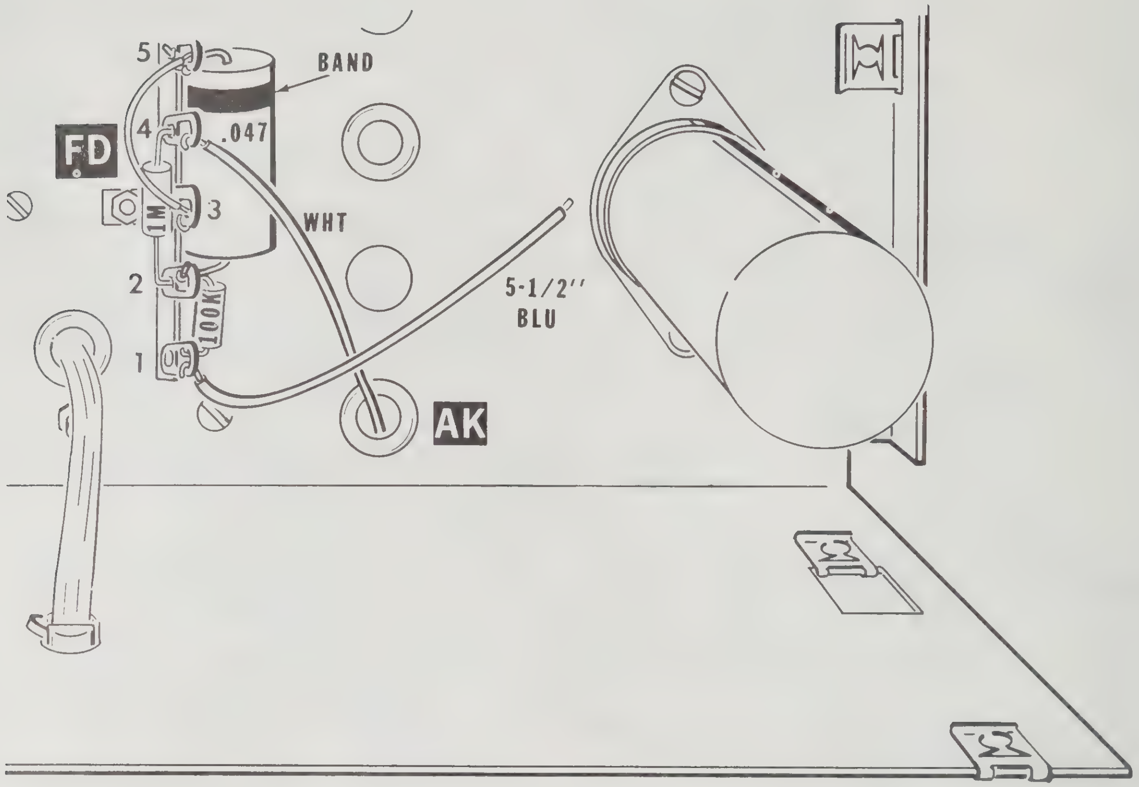
(X) Connect one end of a 7" yellow wire to switch SW3 lug 8 (S-1). Route the other end of this wire down through grommet AC.

( ) Connect one end of a 2-1/2" yellow wire to terminal strip CA lug 6 (S-1). Route this wire toward control R24; it will be connected later.

( ) Connect one end of a 4" violet wire to terminal strip CA lug 7 (S-1). Route this wire toward control R24; it will be connected later.

( ) Connect one end of a 4-1/2" black wire to terminal strip CA lug 10 (S-4). Route this wire toward control R24; it will be connected later.


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



PICTORIAL 8-3

Refer to Pictorial 8-3 for the following steps.

Connect the following parts and wires to terminal strip FD.

( ) R25: Connect a 1 MΩ (brown-black-green) resistor between holes 2 (S-1) and 4 (S-1). Mount this resistor on the side nearest the transformer cage.

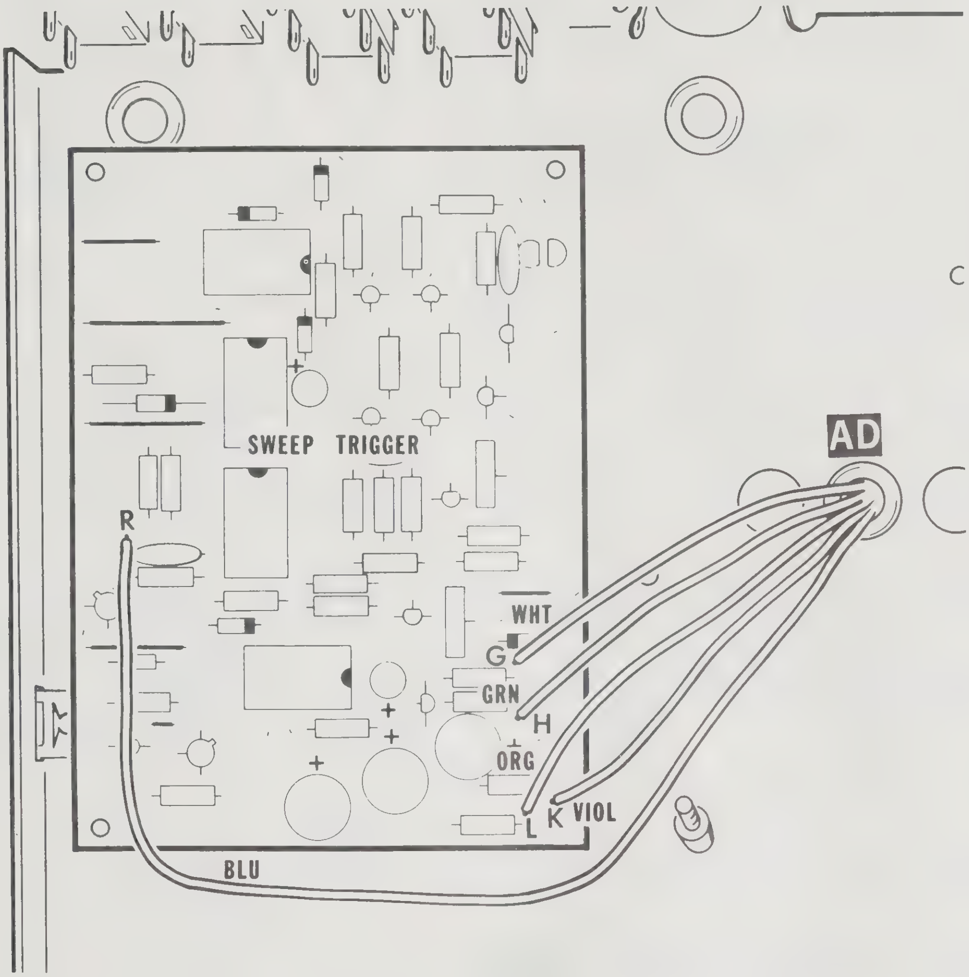
( ) C23: Connect a .047 μF paper capacitor between lugs 2 (NS) and 5 (NS). Mount this capacitor on the side away from the transformer cage. Also be sure to connect the banded end of the capacitor to lug 5.

( ) R26: Connect a 100 kΩ (brown-black-yellow) resistor between lugs 1 (NS) and 2 (S-2).

( ) Connect the white wire coming from grommet AK to lug 4 (S-1).

( ) Prepare a 2" black wire. Connect this wire between lugs 3 (S-1) and 5 (S-2).

( ) Prepare a 5-1/2" blue wire. Connect one end of this wire to lug 1 (S-2). The other end will be connected later.



PICTORIAL 8-4

Refer to Pictorial 8-4 for the following steps.

(X) Locate the assembled sweep-trigger circuit board and place it in the chassis as shown, but not on the chassis studs.

NOTE: In the following steps, the wires coming from grommet AD will be connected to the sweep-trigger circuit board. Solder each wire as you connect it to the board, and cut off any excess wire end.

(✓) White wire to hole G (S-1).

(✓) Green wire to hole H (S-1).

(X) Shorter violet wire to hole K (S-1).

(X) Shorter orange wire to hole L (S-1).

(✓) Blue wire to hole R (S-1). Do not shorten this wire.

Refer to Pictorial 8-5 in the Illustration Booklet for the following steps.

(X) Place the sweep-trigger circuit board onto chassis studs EA, EC, and ED. Do not install nuts on the studs at this time.

(X) Route the long blue wire that is connected to hole R on the circuit board close to the chassis and around studs EC and ED. Position all other wires out from under the blue wire.

Connect the wires and cables coming from the sweep-trigger circuit board as follows:

(X) Shielded cable coming from holes A and B to switch SW4 lug 7 (S-2).

(X) Gray wire coming from hole U to switch SW5 lug 3 (S-1).

(X) Yellow wire of the red-yellow twisted pair to switch SW8 lug 3 (S-1).

(X) Red wire from red-yellow twisted pair to switch SW8 lug 1 (S-1).

(X) Gray wire coming from hole S to switch SW8 lug 2 (S-1).

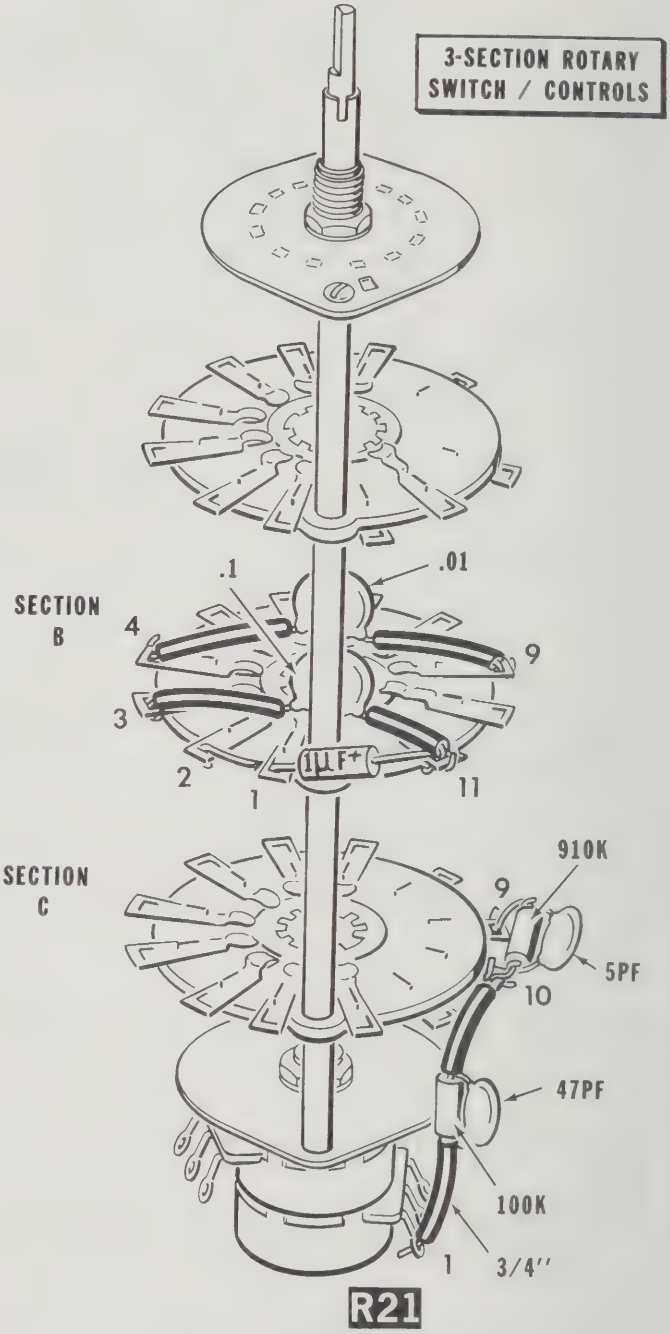
(X) Violet wire coming from hole J to control R13 lug 3 (S-1).

(X) Yellow wire coming from hole E to control R13 lug 2 (S-1).

(X) Black wire coming from hole T to terminal strip CA lug 11 (S-3).

(X) Gray wire coming from hole F to terminal strip CA lug 5 (S-1).

(X) Set the chassis aside temporarily. Be sure to support the left side of the chassis with the input shield.



PICTORIAL 8-6

Refer to Pictorial 8-6 for the following steps.

(X) Locate the 3-section rotary switch/controls (#63-1217) and place it on your work surface as shown. NOTE: The lugs on the rear control should point to your right.

(X) On section B, twist lugs 1 and 2 slightly so the capacitor lead in the next step will pass straight through both lugs.

Connect the following parts and wires to the rotary switch/controls.

NOTE: The marked end of a tantalum capacitor is identified by a plus (+) mark or a colored end on the capacitor.

(X) C22: Insert the lead from the unmarked end (not the marked end) of a 1 μF tantalum capacitor through lug 1 to lug 2. Solder both lugs.

(X) Connect the lead from the marked end of this capacitor to lug 11 (NS).

(X) Cut two 1/2" lengths of sleeving. Then place one length of sleeving on each lead of a .1 μF disc capacitor.

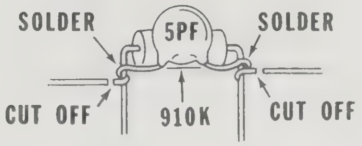
(X) C21: Install the .1 μF disc capacitor on section B between lugs 3 (S-1) and 11 (NS). Position the capacitor inside the frame of the rotary switch as shown.

(X) Check the capacitor that you just installed. Make sure that the capacitor body will not rub against the switch shaft.

(X) Cut two 1/2" lengths of sleeving. Then place one length of sleeving on each lead of a .01 μF disc capacitor.

(X) C19: Install the .01 μF disc capacitor on section B between lugs 4 (S-1) and 9 (NS). Position the capacitor on the other side of the switch shaft from the previously installed capacitor.

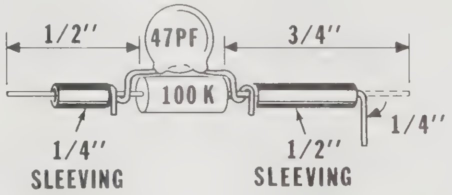
(X) Check the capacitor that you just installed. Make sure that the capacitor body will not rub against the switch shaft.



Detail 8-6A

(X) Locate a 910 kΩ (white-brown-yellow) resistor and a 5 pF disc capacitor. Then refer to Detail 8-6A and prepare a resistor-capacitor combination.

(X) R18, C14: Connect the resistor-capacitor combination to section C between lugs 9 (NS) and 10 (NS). Insert the leads from the front of the section and spread them apart to hold the combination in place.

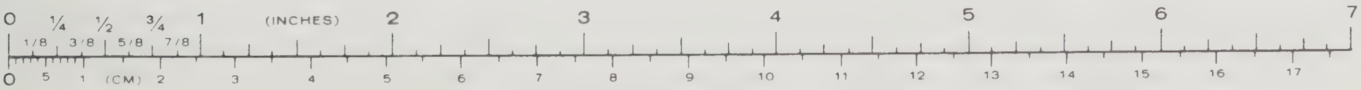


Detail 8-6B

(X) Locate a 100 kΩ (brown-black-yellow) resistor and a 47 pF disc capacitor. Then refer to Detail 8-6B and prepare a resistor-capacitor combination as follows:

1. Cut one resistor lead to 1/2" and the other lead to 3/4".
2. Solder the capacitor leads close to the resistor. Cut off the excess capacitor lead lengths.
3. Place 1/4" of sleeving on the 1/2" lead and 1/2" of sleeving on the 3/4" lead.
4. Bend the 3/4" lead as shown.

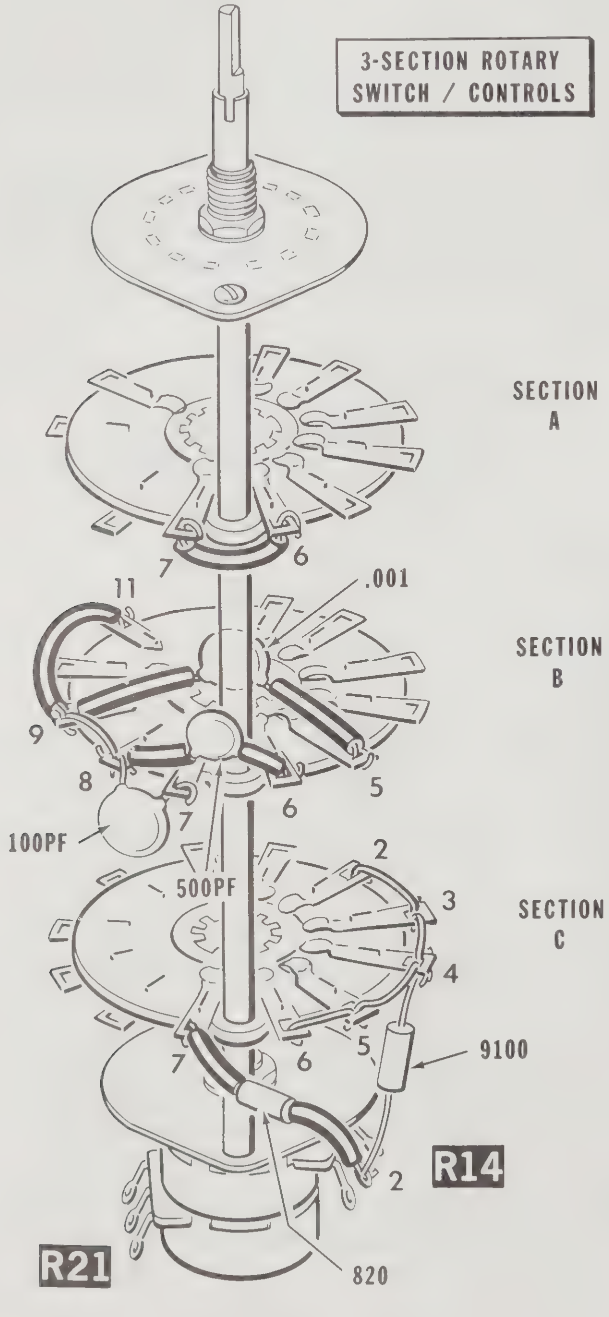
(X) R19, C15: Connect this resistor-capacitor combination between section C lug 10 (S-2) and control R21 lug 1 (NS).


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Refer to Pictorial 8-7 for the following steps.

(✓) Position the rotary switch/controls as shown. Note that the lugs on control R21 should point to your left.

(✓) Cut both leads of a .001 μF disc capacitor to 3/4". Then place 1/2" of sleeving on each lead.



PICTORIAL 8-7

(✓) C18: Connect the .001 μF disc capacitor to section B between lugs 9 (NS) and 5 (S-1). Position the switch inside the frame of the switch.

(✓) C16: Connect a 100 pF disc capacitor to section B between lugs 7 (S-1) and 8 (NS).

(✓) Cut two 1/4" lengths of sleeving. Then place one length of sleeving on each lead of a 500 pF disc capacitor.

(✓) C17: Connect the 500 pF disc capacitor to section B between lugs 8 (NS) and 6 (S-1). Mount this capacitor outside the frame.

(✓) Connect a 1" bare wire to section B between lugs 9 (NS) and 8 (S-3).

(✓) Prepare a 1-1/4" red wire. Connect this wire to section B between lugs 11 (NS) and 9 (S-4). Make sure that all four leads at lug 9 are soldered.

(✓) Prepare a 1" red wire. Connect this wire to section A between lugs 6 (NS) and 7 (S-1).

(✓) Cut four 1" lengths of bare wire. Use these wires in the next four steps.

(✓) Connect a 1" bare wire to section C between lugs 6 (S-1) and 5 (NS).

(✓) Connect a 1" bare wire to section C between lugs 5 (S-2) and 4 (NS).

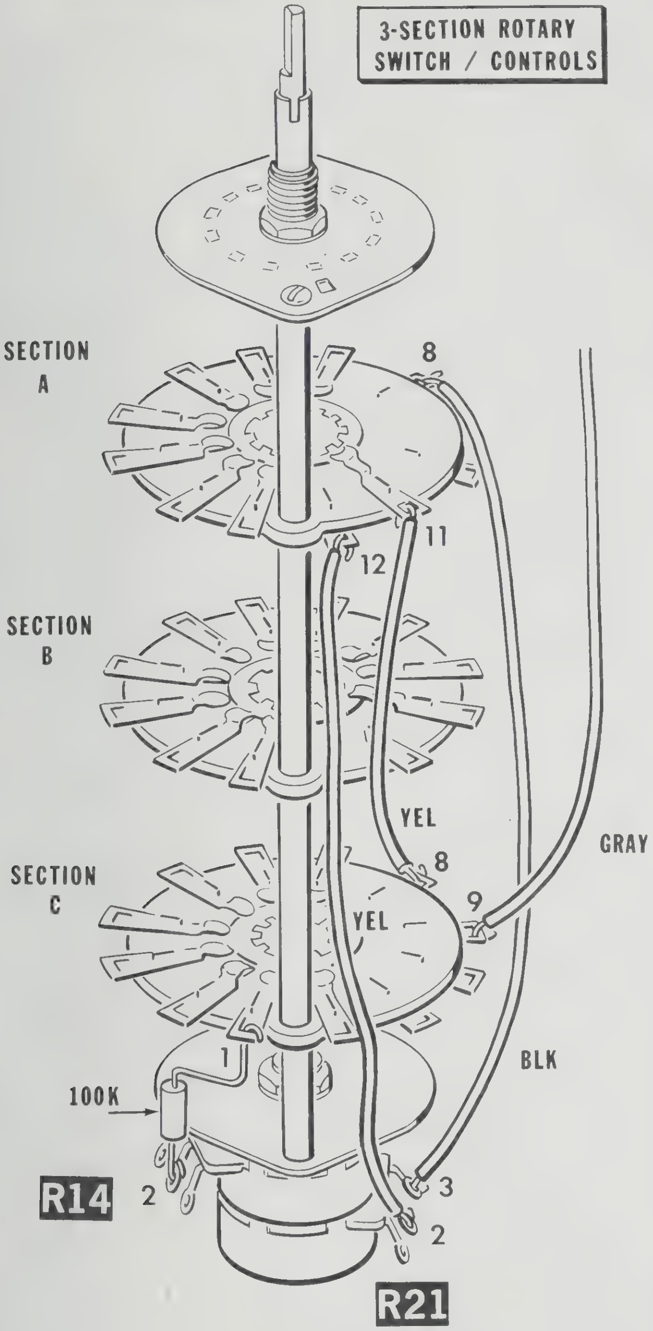
(✓) Connect a 1" bare wire to section C between lugs 4 (NS) and 3 (NS).

(✓) Connect a 1" bare wire to section C between lugs 3 (S-2) and 2 (S-1).

(✓) R10: Connect a 9100 Ω (white-brown-red) resistor between section C lug 4 (S-3) and control R14 lug 2 (NS).

(✓) Cut a 3/4" length of sleeving and a 1/2" length of sleeving. Place one piece of sleeving on each lead of an 820 Ω (gray-red-brown) resistor.

(✓) R17: Connect the 820 Ω resistor between section C lug 7 (S-1) and control R14 lug 2 (NS).



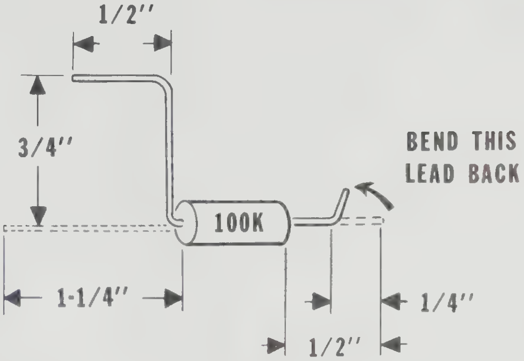
PICTORIAL 8-8

Refer to Pictorial 8-8 for the following steps.

(X) Position the rotary switch/controls as shown. Note that the lugs of control R21 point to your right.

(X) Refer to Detail 8-8A and prepare the leads of a 100 kΩ (brown-black-yellow) resistor.

(X) R15: Connect the 100 kΩ resistor between section C lug 1 (S-1) and control R14 lug 2 (S-3).



Detail 8-8A

(X) Prepare the following wires:

3-3/4" yellow
3-1/2" black
2-1/2" yellow
7" gray

(X) Connect a 3-3/4" yellow wire between section A lug 12 (S-1) and control R21 lug 2 (S-1).

(X) Connect a 3-1/2" black wire between control R21 lug 3 (NS) and section A lug 8 (S-1).

(X) Connect a 2-1/2" yellow wire between section A lug 11 (NS) and section C lug 8 (S-1).

(X) Connect one end of a 7" gray wire to section C lug 9 (S-2).

Carefully inspect the connections on the 3-section rotary switch/controls. Make sure that:

(X) Section A lugs 12, 8, and 7 are soldered.

( ) All of the lugs on section B except lugs 10 and 11 are soldered.

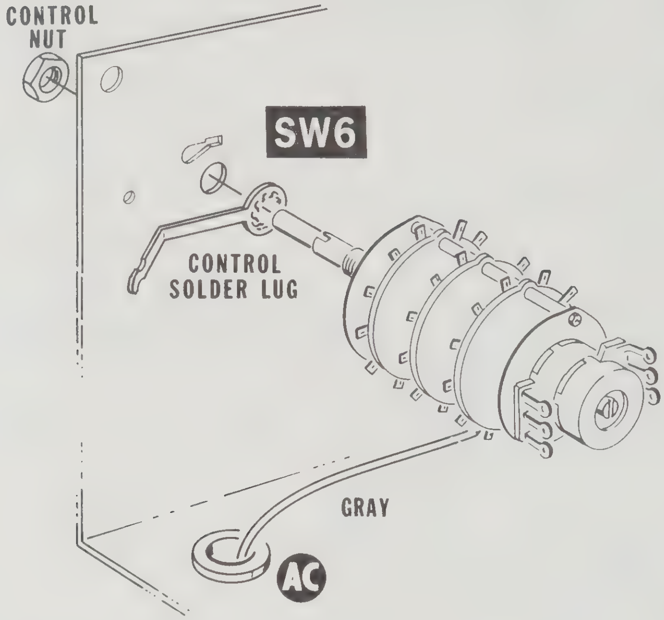
( ) All of the lugs on section C except lugs 11 and 12 are soldered.

( ) Lug 2 (center lug) on each control is soldered.

( ) None of the connections touch any lugs other than the ones they are connected to.

(X) The disc capacitors that are within the switch frame do not interfere with the switch rotors. Also, make sure they do not rub against the switch shaft.

0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 CM 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



PICTORIAL 9-1

Refer to Pictorial 9-1 for the following step.

☒ SW6, R14, R21: Mount the 3-section rotary switch/controls at SW6 with a control solder lug and a control nut. Be sure to position the switch and solder lug as shown. Bend the transistor that is under the rotary switch toward the rear panel if it interferes with switch mounting.

☒ Insert the gray wire coming from rotary switch SW6, section C, down through grommet AC.

☒ Set the chassis aside temporarily and locate the plastic front subpanel.

Refer to Pictorial 9-2 for the following steps.

☒ Position the plastic front subpanel on your work surface as shown.

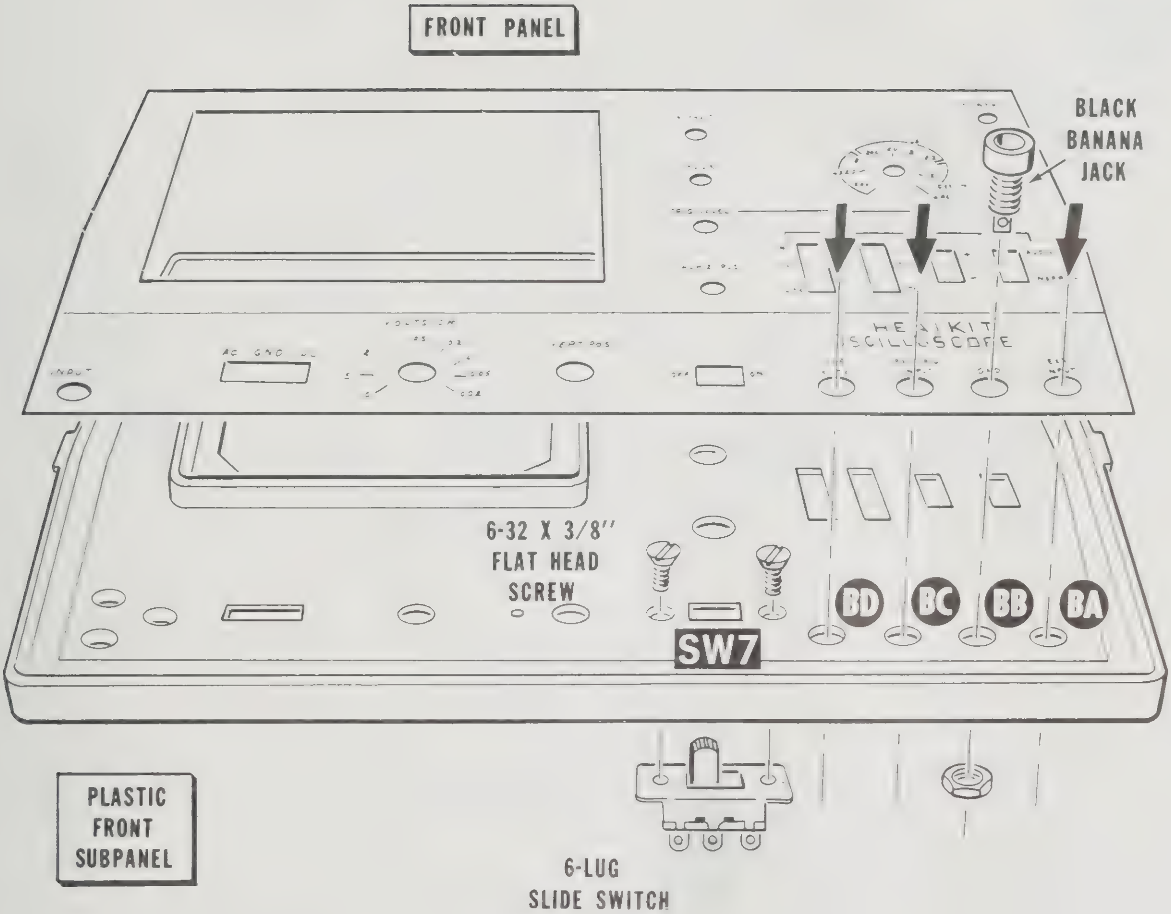
☒ SW7: Install a 6-lug slide switch at SW7 with two 6-32 x 3/8" flat head screws.

NOTE: In the next step you will install the adhesive-backed front panel to the plastic front subpanel. Once the adhesive is stuck to the front subpanel, it can not be removed. Therefore, carefully line up the holes in the front panel with the holes in the front subpanel before you allow the two panels to touch.

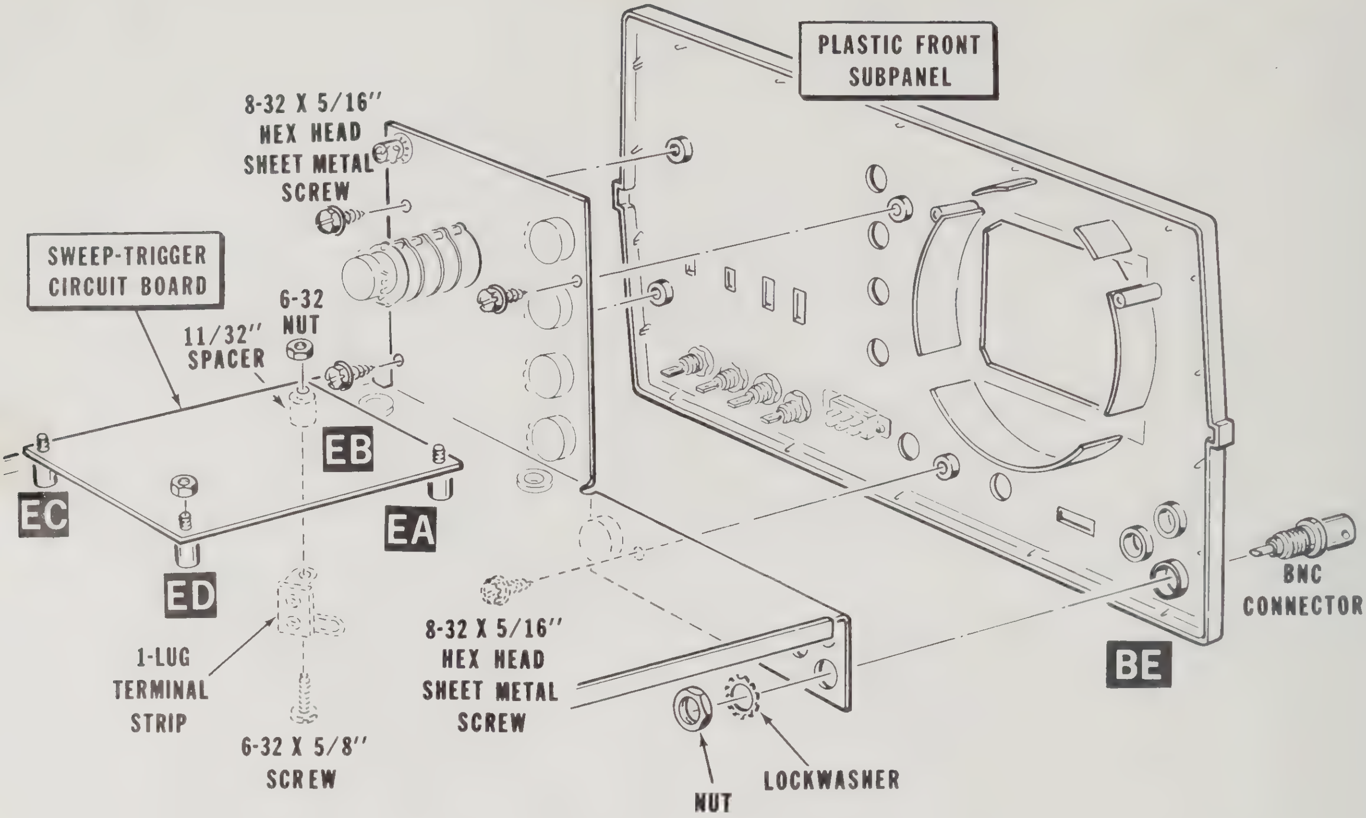
☒ Remove the protective paper backing from the front panel. Then press the front panel onto the plastic front subpanel.

☒ Install a black banana jack at BB. Use the nut supplied on the jack.

☒ In the same manner, install red banana jacks at BA, BC, and BD.



PICTORIAL 9-2



PICTORIAL 9-3

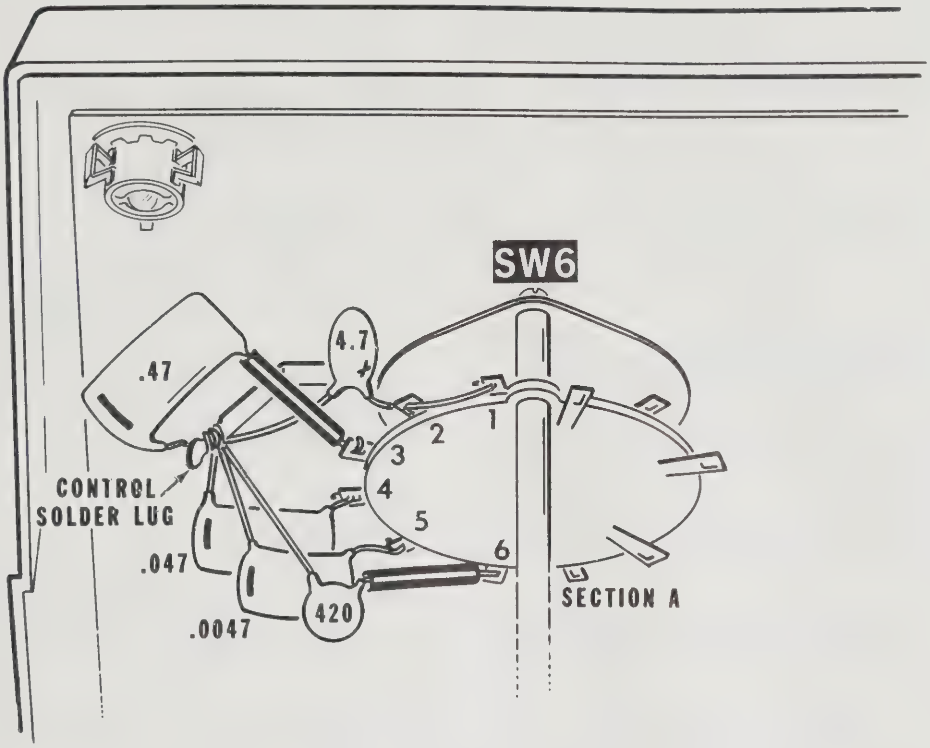
Refer to Pictorial 9-3 for the following steps.

(X) Mount the front subpanel to the chassis with four #8 x 5/16" hex head sheet metal screws. Lift the sweep trigger circuit board off the chassis studs to provide more room to install the lower left screw.

(X) Install the BNC connector at BE. Use the hardware supplied with the connector.

(X) Mount a 1-lug terminal strip and an 11/32" spacer at EB with a 6-32 x 5/8" screw. Mount the terminal strip to the underside of the chassis and the spacer on top of the chassis.

(X) Mount the sweep-trigger circuit board to the chassis studs at EA, EB, EC, and ED. Use a 6-32 nut on each stud.



PICTORIAL 9-4

Refer to Pictorial 9-4 for the following steps:

☒ Position the chassis as shown.

Connect the following capacitors between rotary switch SW6, section A, and the control solder lug.

☒ C8: Connect the plus (+) marked lead of a 4.7 μF tantalum capacitor through lug 2 (S-2) to lug 1 (S-1). Crimp the other lead around the control solder lug (NS).

☒ C9: Place 1/2" of sleeving on one lead of a .47 μF Mylar capacitor. Then connect this lead to lug 3 (S-1). Crimp the other lead around the control solder lug (NS).

☒ C11: Connect one lead of a .047 μF Mylar capacitor to lug 4 (S-1). Crimp the other lead around the control solder lug (NS).

☒ C12: Connect one lead of a .0047 μF Mylar capacitor to lug 5 (S-1). Crimp the other lead around the control solder lug (NS).

☒ C13: Place 1/2" of sleeving on one lead of a 420 pF disc capacitor. Then connect this lead to lug 6 (S-2). Crimp the other lead around control solder lug (S-5).

Refer to Pictorial 9-5 in the Illustration Booklet for the following steps:

Connect the following wires coming from terminal strip CA to rotary switch SW6 and control R21 as follows:

☒ Yellow wire to section A lug 11 (NS).

☒ Violet wire to section C lug 12 (S-1).

☒ Black wire to control R21 lug 1 (NS).

Connect the wires coming from the sweep-trigger circuit board to rotary switch SW6 and control R14 as follows:

☒ Yellow wire (of the orange and yellow twisted pair) to section B lug 10 (S-1).

☒ Orange wire (of the orange and yellow twisted pair) to section B lug 11 (S-4).

☒ Orange wire coming from hole D to control R14 lug 1 (S-1).

☒ Inner lead of the shielded cable to section A lug 11 (S-3). Make sure that the shield lead at the other end of this cable does not touch the case of transistor Q310.

Refer to Pictorial 9-6 in the Illustration Booklet for the following steps.

☒ Place the horizontal amplifier circuit board (this is the circuit board with three controls) on the chassis as shown. Do not mount the circuit board into the studs.

Connect the following wires to the horizontal amplifier circuit board:

☒ Connect the orange wire coming from grommet AD to hole G (S-1).

☒ Connect the violet wire coming from grommet AD to hole M (S-1).

☒ Connect the black wire coming from grommet AF to hole N (S-1).

☒ Connect the red wire coming from grommet AF to hole L (S-1).

Connect the wires of the 3-wire twisted cable coming from control R22 to the horizontal amplifier circuit as follows:

☒ Violet wire to hole B (S-1).

☒ Orange wire to hole A (S-1).

☒ Yellow wire to hole C (S-1).

☒ Inspect the foil side of the horizontal amplifier circuit board. Cut off any excess lead lengths that could touch the chassis after the circuit board is installed.

☒ Mount the horizontal amplifier circuit board to the chassis studs at EE, EF, EG, and EH, with four 6-32 nuts.

Connect the shielded cables coming from the horizontal amplifier circuit board to rotary switch SW6 and control R21 as follows:

☒ Connect the inner lead of the shielded cable coming from holes H and P to section A lug 10 (S-1).

☒ Connect the inner lead of the shielded cable coming from holes D and E to section C lug 11 (S-1).

☒ Connect the inner lead of the shielded cable coming from hole F to control R21 lug 3 (S-2), and connect the shield lead to lug 1 (S-3).

Refer to Pictorial 9-7 in the Illustration Booklet for the following steps:

(X) Place the vertical amplifier circuit board (this is the circuit board with five controls) on the chassis as shown. Do not mount the circuit board onto the studs.

(X) Insert the shielded cable coming from holes L and K on the circuit board down through grommet AE and up through grommet AD.

(X) Connect the inner lead of this shielded cable coming from grommet AD to terminal strip CA lug 8 (S-1). Be careful that you do not burn the other wires in this area with your soldering iron.

Connect the wires of the three wire twisted cable coming from grommet AE to the vertical amplifier circuit board as follows:

(X) Yellow wire to hole T (S-1).

(X) Orange wire to hole U (S-1).

(X) Violet wire to hole A (S-1).

Connect the other orange and violet wires coming from grommet AE to the vertical amplifier circuit board as follows:

(X) Orange wire to hole G (S-1).

(X) Violet wire to hole J (S-1).

(X) Connect the red wire coming from grommet AA to hole D on the vertical amplifier circuit board (S-1).

Connect the shielded cables coming from grommet AA as follows:

(X) Shielded cable without a shield lead; inner lead to hole F (S-1).

(X) Cut the shield lead off the other shielded cable. The shield lead was left on only for identification purposes.

(X) Connect the inner lead of this shielded cable to hole H (S-1).

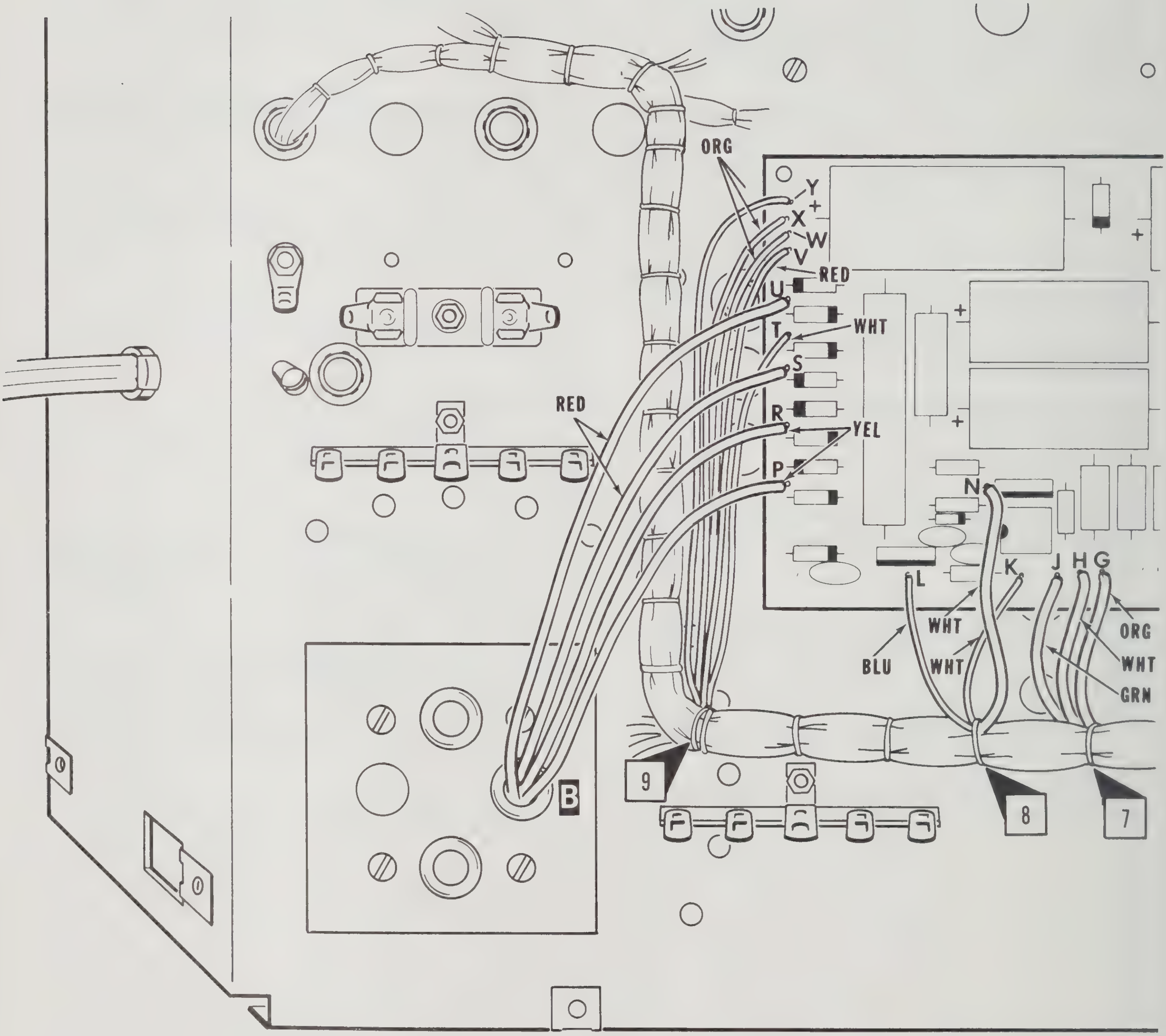
Connect the wires coming from grommet AG to the vertical amplifier circuit board as follows:

(X) Red-white wire to hole R (S-1).

(X) Black wire to hole P (S-1).

(X) Inspect the foil side of the vertical amplifier circuit board. Cut off any excess lead lengths that could touch the chassis after the circuit board is installed.

(X) Mount the vertical amplifier circuit board on the four chassis studs at EJ, EL, EK and EN with four 6-32 nuts.



PICTORIAL 10-1

Refer to Pictorial 10-1 for the following steps.

(X) Position the chassis bottom-side-up with the front panel to your right.

(X) Set the power supply circuit board on the chassis. Do not mount it on the studs.

Connect the wires coming from BO#9 to the power supply circuit board as follows:

(X) Either orange wire to hole Y (S-1).

(X) Another orange wire to hole X (S-1).

(X) Remaining orange wire to hole W (S-1).

(X) Red wire to hole V (S-1).

(X) White wire to hole T (S-1).

Connect the wires coming from grommet B to the power supply circuit board as follows:

(X) Either red wire to hole U (S-1).

(X) Other red wire to hole S (S-1).

(X) Either yellow wire to hole R (S-1).

(X) Other yellow wire to hole P (S-1).

Connect the wires coming from BO#8 to the power supply circuit board as follows:

(X) Blue wire to hole L (S-1).

(X) Short white wire to hole K (S-1).

(X) Long white wire to hole N (S-1).

Connect the wires coming from BO#7 to the power supply circuit board as follows:

(X) Green wire to hole J (S-1).

(X) White wire to hole H (S-1).

(X) Orange wire to hole G (S-1).

Refer to Pictorial 10-2 in the Illustration Booklet for the following steps.

Connect the wires coming from BO#6 to the power supply circuit board as follows:

(X) Either red wire to hole F (S-1).

(X) Other red wire to hole E (S-1).

(X) Green wire to hole D (S-1).

(X) Prepare an 11" blue wire.

(X) Connect one end of this blue wire to hole M on the power supply circuit board (S-1).

Connect the wires coming from BO#5 to the power supply circuit board as follows:

(X) Either red wire to hole C (S-1).

(X) Other red wire to hole B (S-1).

(X) Black wire to hole DD (S-1).

Connect the wires coming from BO#4 to the power supply circuit board as follows:

(X) Green wire to hole A (S-1).

(X) Either violet wire to hole CC (S-1).

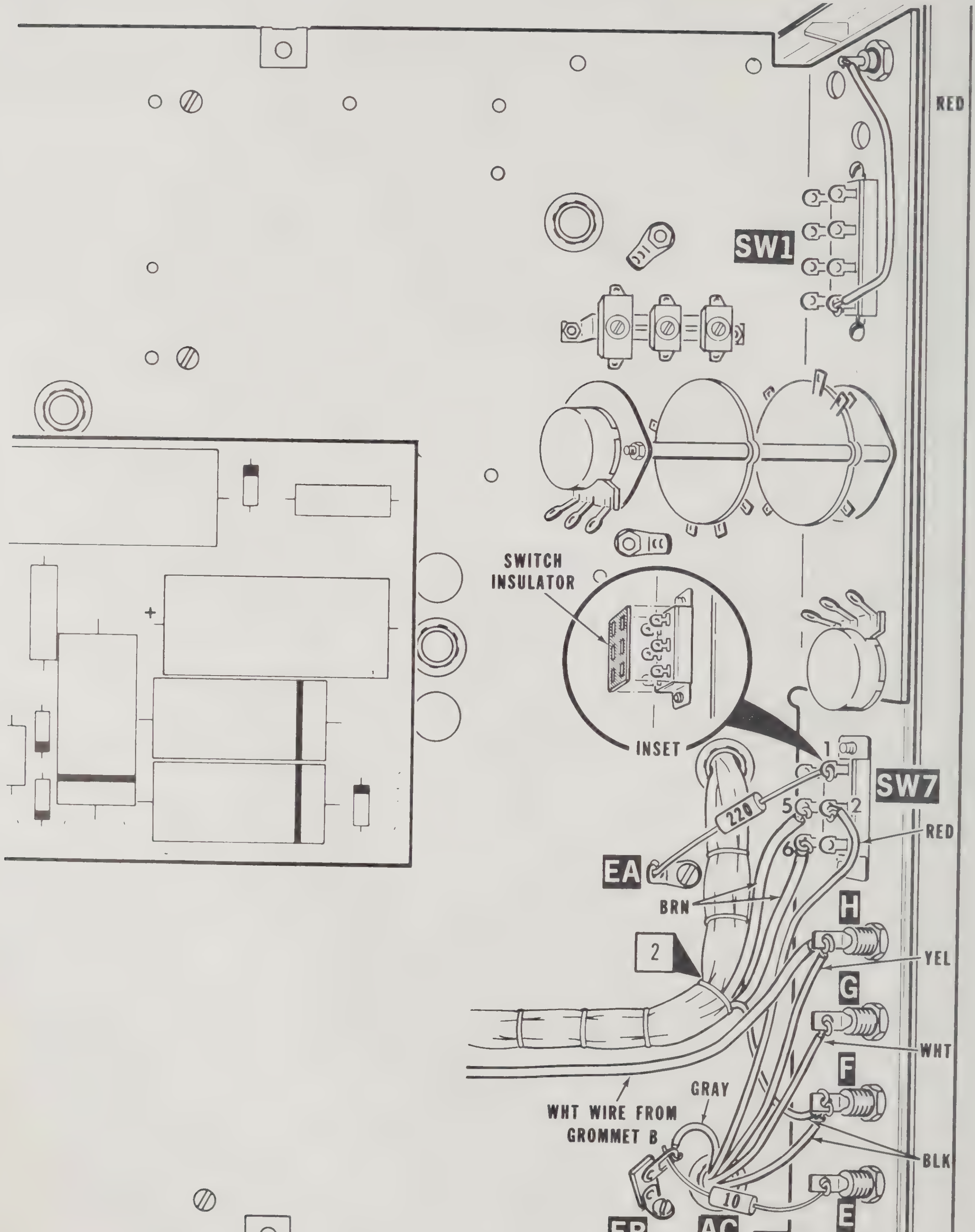
(X) Another violet wire to hole BB (S-1).

(X) Remaining violet wire to hole AA (S-1).

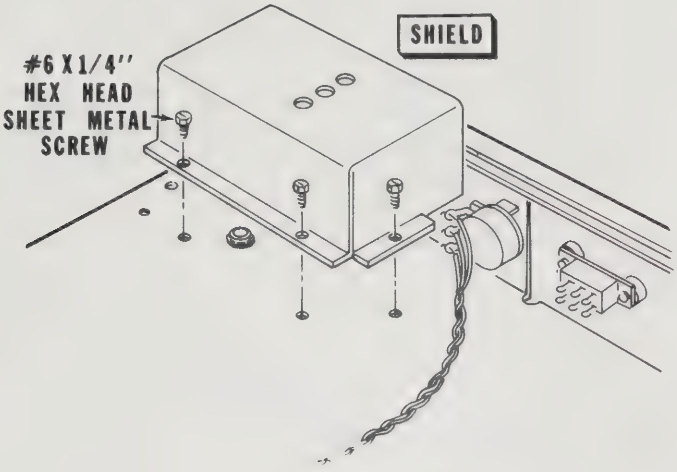
(X) Inspect the foil side of the power supply circuit board. Cut off any excess lead lengths that could touch the chassis after the circuit board is installed.

(X) Mount the power supply circuit board to the chassis studs with four 6-32 nuts. Make sure that the shielded cable coming from grommet AD is positioned around the circuit board, not under it.

(X) Route the blue wire coming from hole M on the power supply circuit board down through grommet AH. This wire will be connected later.



PICTORIAL 10-3



PICTORIAL 10-4

Refer to Pictorial 10-3 for the following steps.

(X) Refer to the inset drawing and install the switch insulator over the lugs of switch SW7.

Connect the wires coming from BO#2 as follows:

(X) Either brown wire to switch SW7 lug 5 (S-1). Make this connection mechanically secure.

(X) Other brown wire to switch SW7 lug 6 (S-1). Make this connection mechanically secure.

(X) Black wire to banana jack F (NS).

(X) Connect a 220 Ω (red-red-brown) resistor between switch SW7 lug 1 (S-1) and the solder lug at EA (S-1).

Connect the wires coming from grommet AC as follows:

terminal strip EB(NS)
(X) Gray wire to ~~banana jack E (S-1)~~.
(X) R20: Connect a 10 Ω (brown black black)
(X) Black wire to banana jack F (S-2).

resistor between terminal strip EB(S-2)
and banana jack E(S-1). Keep leads short!

(X) White wire to banana jack G (S-1).

(X) Yellow wire to banana jack H (NS).

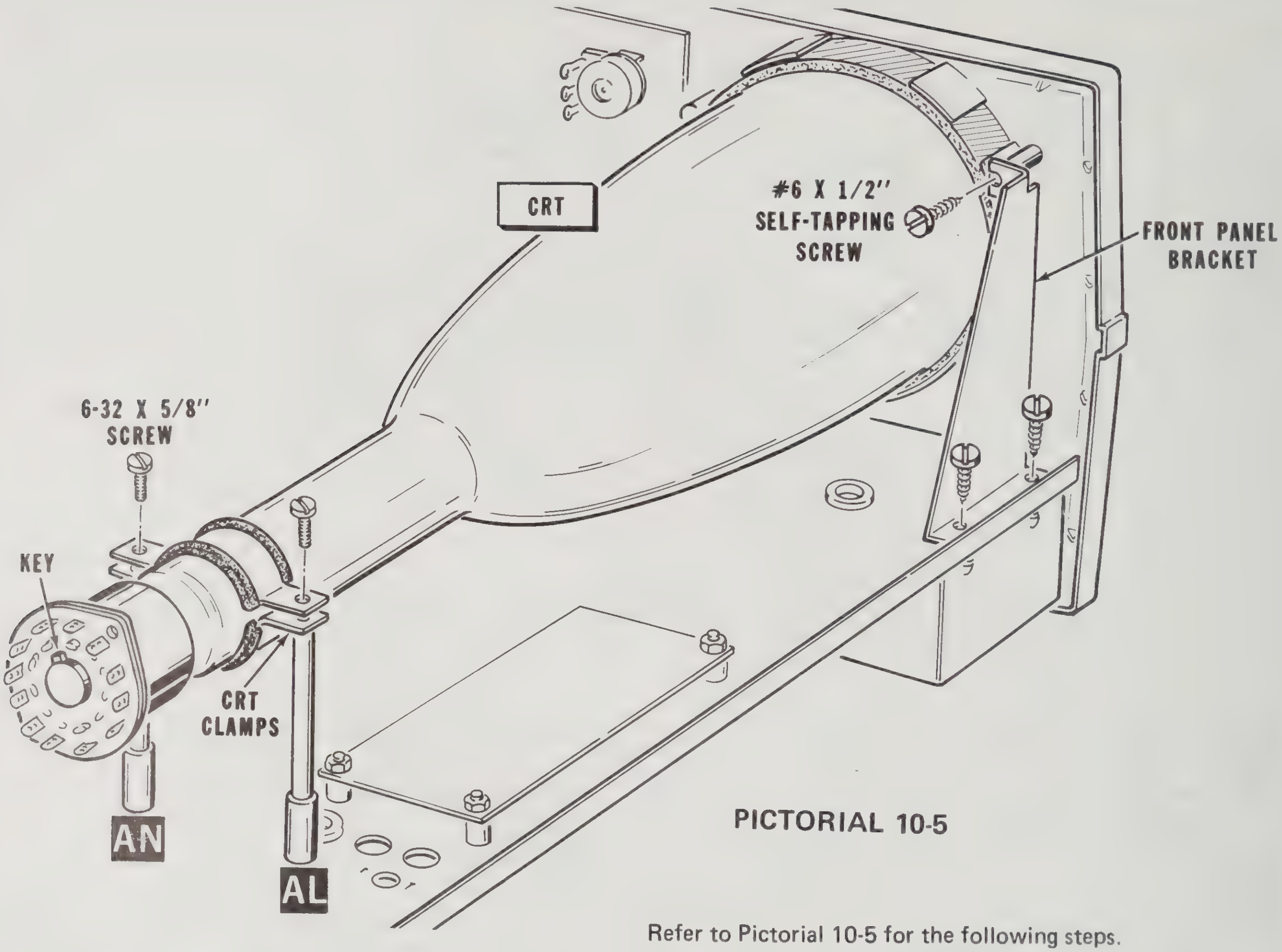
(X) Red wire to switch SW7 lug 2 (S-1).

(X) Locate the long white wire coming from grommet B near the rear of the chassis. Connect this wire to banana jack H (S-2).

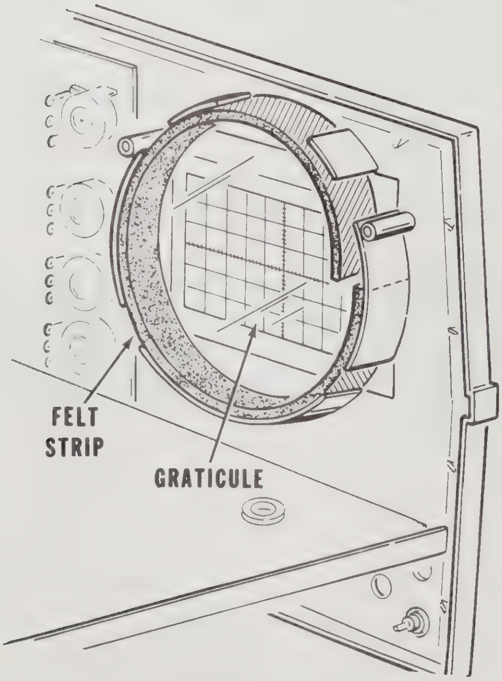
(X) Connect the red wire coming from switch SW1 to the BNC connector (S-1).

Refer to Pictorial 10-4 for the following steps.

(X) Mount the input shield to the underside of the chassis (over the rotary switch and the 3-section trimmer) with three #6 x 1/4" hex head sheet metal screws. Be sure that the three-wire twisted cable is positioned out of the way.



PICTORIAL 10-5



Detail 10-5A

Refer to Pictorial 10-5 for the following steps.

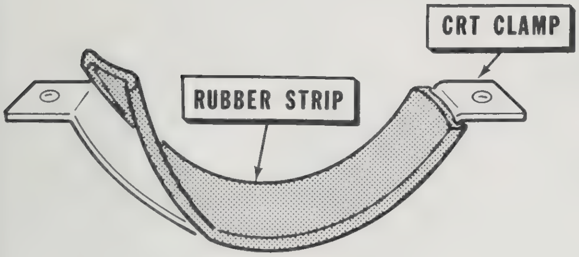
(X) Position the chassis right-side-up with the front away from you.

(X) Locate the graticule and remove the protective backing. (There may be a protective film on both sides.) Then refer to Detail 10-5A and place the graticule in the large opening in the plastic front subpanel from the back side. Position the printed side of the graticule to the front.

(X) Refer to Detail 10-5A and remove the protective paper backing from the felt strip. Then press the felt to the inside of the CRT ring, starting on the side nearest the edge of the plastic front subpanel. Do not allow the felt to overlap at the ends, trim off excess.

(X) Mount the front panel bracket to the plastic front subpanel and the chassis with three #6 x 1/2" self-tapping screws.

(X) Locate the rubber strip and cut it into two equal lengths.



Detail 10-5B

(X) Refer to Detail 10-5B and place a length of rubber strip onto each CRT clamp.

WARNING: Handle the CRT very carefully. Because of its high vacuum, do not strike, scratch, or subject the CRT to more than moderate pressure at any time. A fracture of the glass could result in an implosion of considerable violence capable of causing personal injury.

(X) Carefully unpack the CRT.

(X) Place the CRT face down on a cloth and press the CRT socket onto the pins of the CRT. NOTE: The socket may not fit all the way onto the pins.

(X) Push the face of the CRT into the CRT ring in the plastic front subpanel.

(X) Install the two CRT clamps around the CRT neck and mount them to the two threaded spacers at AL and AN. Use two 6-32 x 5/8" screws. Do not tighten the screws.

(X) Position the CRT and socket so the locating key on the socket is at the 11 o'clock position.

Refer to Pictorial 10-6 in the Illustration Booklet for the following steps.

(X) Locate a 10 MΩ (brown-black-blue) resistor and bend the leads close to the resistor body. Then connect the resistor to the CRT socket between lugs 1 (NS) and 2 (NS).

Connect the wires coming from grommet AK to the CRT socket as follows:

(X) White-red wire to lug 8 (S-1).

(X) Green wire to lug 12 (S-1).

(X) Red wire to lug 1 (S-2).

(X) Yellow wire to lug 4 (S-1).

(X) Connect the blue wire coming from grommet AH to CRT socket lug 2 (S-2).

(X) Connect the blue wire coming from terminal strip FD to CRT socket lug 3 (S-1).

NOTE: In the next four steps you will connect the twin leads coming from the vertical and horizontal amplifier circuit boards to the CRT socket. There are two individual wires in each twin lead. It is important that you connect the correct wire to each lug. To make sure you have the correct wire, trace the wire back along the twin lead to its hole on the circuit board.

Connect the twin lead coming from the horizontal amplifier circuit board to the CRT socket as follows:

(X) Twin lead wire coming from hole K to lug 9 (S-1).

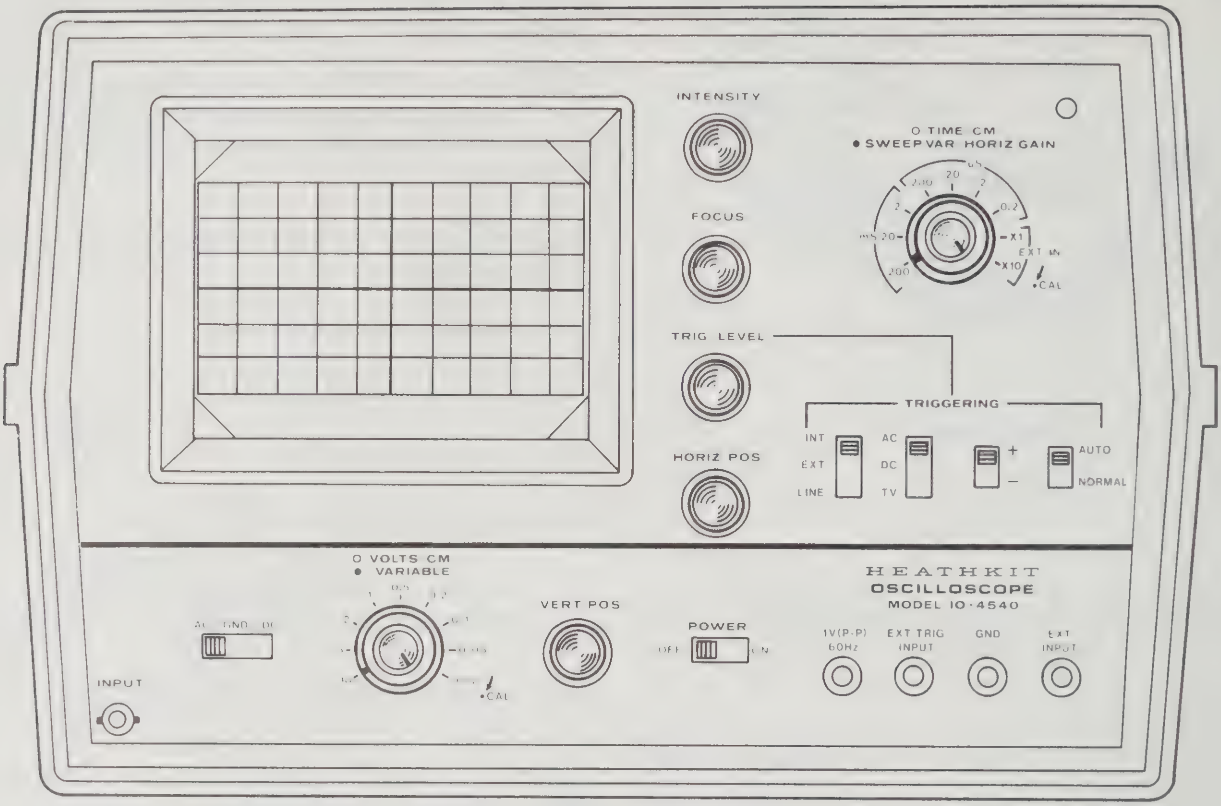
(X) Twin lead wire coming from hole J to lug 10 (S-1).

Connect the twin lead coming from the vertical amplifier circuit board to the CRT socket as follows:

(X) Twin lead wire coming from hole S to lug 7 (S-1).

(X) Twin lead wire coming from hole M to lug 6 (S-1).

(X) Position both twin leads so they do not touch the long threaded spacers or any other metal.



PICTORIAL 10-7

Refer to Pictorial 10-7 for the following steps.

(✓) Locate five knob inserts that have large triangular holes. Use these knob inserts in the following steps.

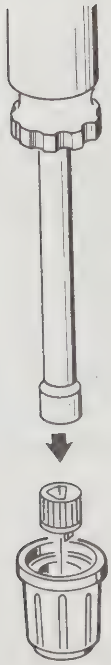
(✓) Locate five small black knobs. Then refer to Detail 10-7A and press a knob insert into each knob. Note that one end of each insert is slightly beveled. Insert this end into the knob.

NOTE: If any of the knobs rub against the front panel after they have been installed, pull the knob away from the panel slightly.

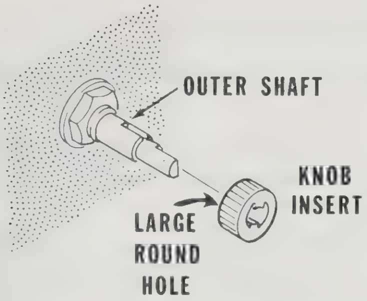
(✓) Push a small black knob onto the Vert Pos control shaft.

(✓) In the same manner push small black knobs onto the following control shafts:

Horiz Pos
Trig Level
Focus
Intensity



Detail 10-7A



Detail 10-7B

(X) Locate two knob inserts with large round holes. Use these in the following steps.

(X) Refer to Detail 10-7B and slide one knob insert onto the outer shaft of the Volts/CM control. Make sure the shaft is turned full counterclockwise.

(X) Slide the other knob insert onto the outer shaft of the Time/CM control. Make sure the shaft is turned full counterclockwise.

(X) Locate two large black knobs. Use these in the following steps. The first knob will be installed on the Volts/CM selector.

NOTE: In the following steps you will align the pointer on the knob with a certain place on the front panel. Once the knob insert has been installed it can not be removed, so perform the following steps carefully.

(X) Align the pointer on the knob with "10" on the front panel and push the knob part way onto the insert. Then remove the knob and insert from the shaft.

(X) Refer to Detail 10-7C and seat the insert into the knob.

(X) Reinstall the knob on the control shaft with the pointer at "10."

(X) In the same manner, install a large black knob on the Time/CM control shaft with the pointer at "200" in the full counterclockwise position. Support the panel from behind with your hand.

(X) Reinstall the knob on the control shaft with the pointer at "200."

(X) Locate the remaining two knob inserts with small triangular holes. Slide these onto the inner shafts of the Variable and Sweep Var/Horiz Gain control shafts. Turn both of these shafts fully clockwise.

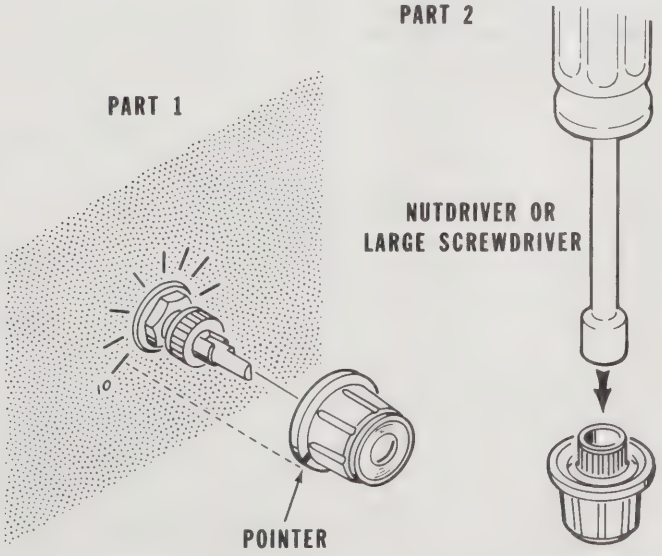
(X) Slide a small red knob onto the Variable control shaft. Align the pointer on the knob with "Cal" on the front panel and push the knob part way onto the insert. Then remove the knob and insert from the shaft and seat the insert in the knob.

(X) Reinstall the knob on the control shaft with the pointer at "Cal."

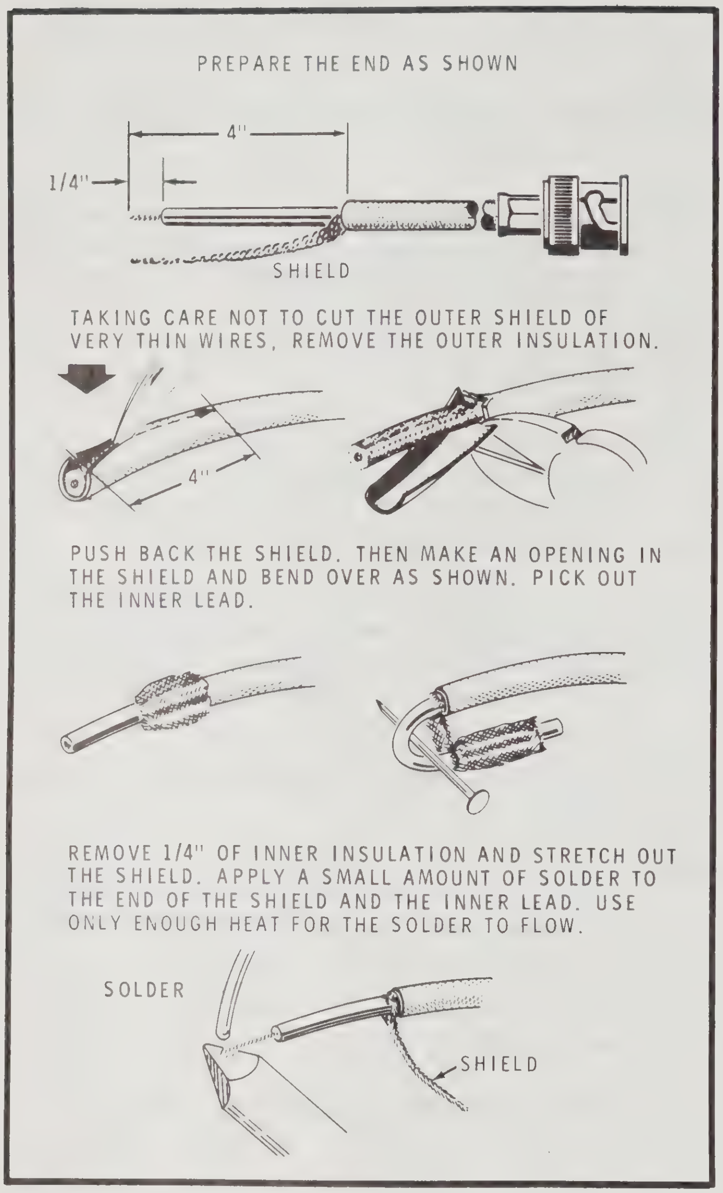
(X) In the same manner, install the remaining knob on the Sweep Var/Horiz Gain control shaft. Align the pointer on the knob with "Cal" on the front panel. Support the panel from behind with your hand.

(X) Reinstall the knob on the control shaft with the pointer at "Cal."

( ) Set the chassis aside and locate the test cable.



Detail 10-7C


PREPARE THE END AS SHOWN

TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.

PUSH BACK THE SHIELD. THEN MAKE AN OPENING IN THE SHIELD AND BEND OVER AS SHOWN. PICK OUT THE INNER LEAD.

REMOVE 1/4" OF INNER INSULATION AND STRETCH OUT THE SHIELD. APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEAD. USE ONLY ENOUGH HEAT FOR THE SOLDER TO FLOW.

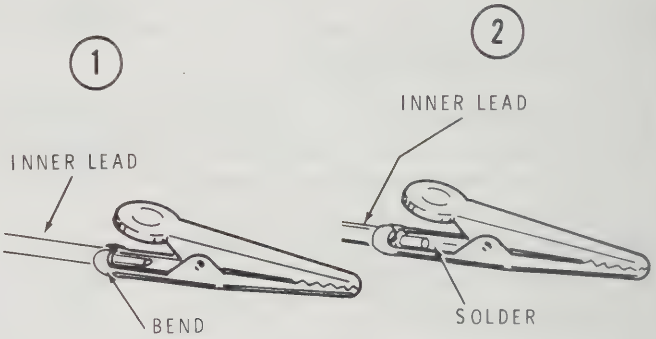
Detail 10-8A

TEST CABLE ASSEMBLY

Refer to Pictorial 10-8 (on Page 109) for the following steps.

(X) Refer to Detail 10-8A and prepare the indicated end of the cable assembly as shown.

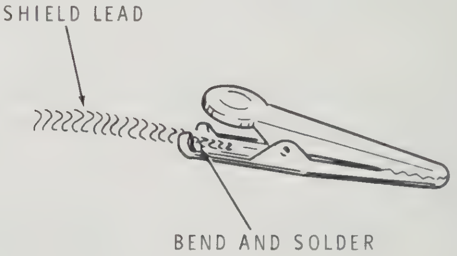
(X) Refer to Pictorial 10-8 and push rubber insulators onto the inner lead and the shield lead of the cable.



Detail 10-8B

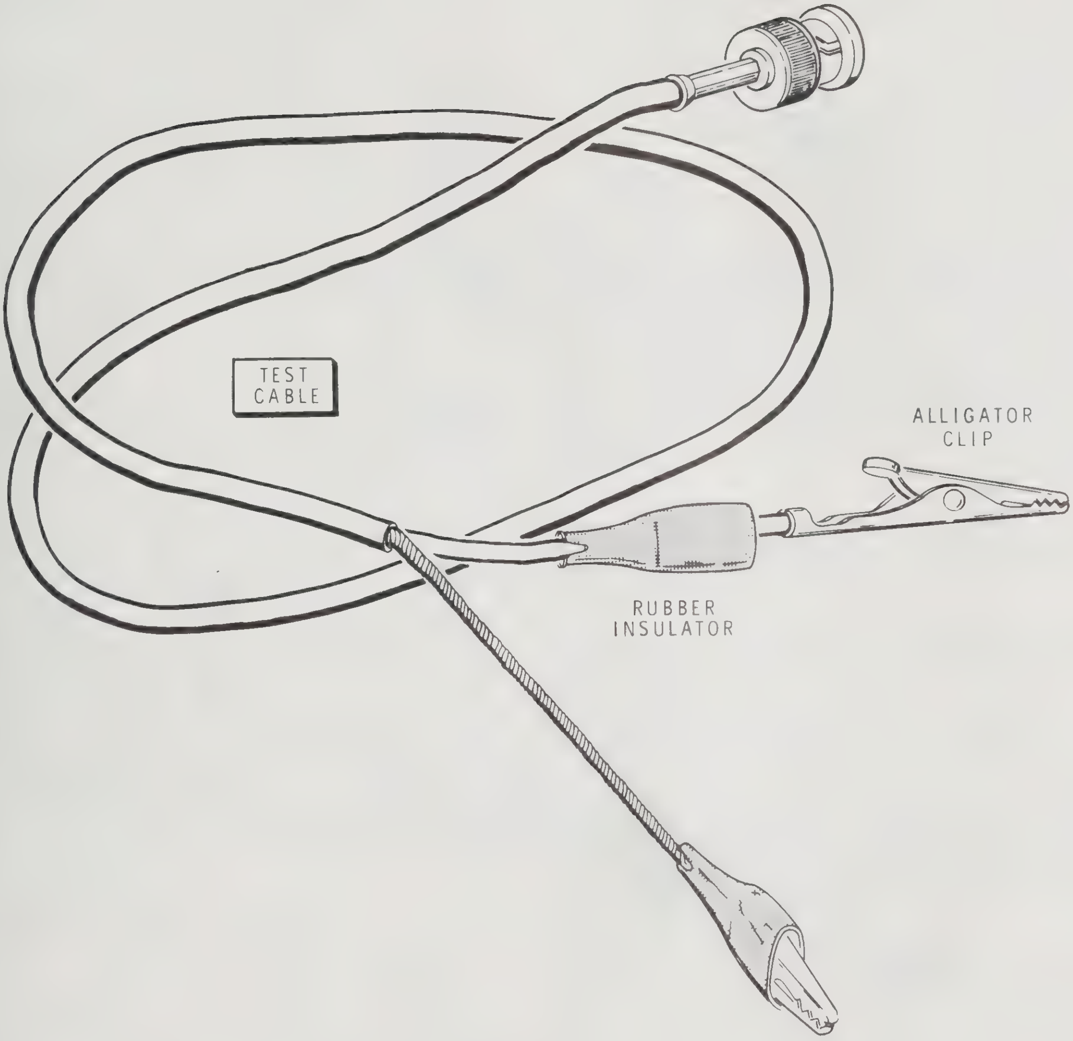
( ) Refer to Detail 10-8B and install an alligator clip on the inner lead of the cable as shown in Parts 1 and 2 of the Detail.

( ) Refer to Detail 10-8C and install an alligator clip on the shield lead of the cable as shown. Then push the rubber insulators down over the alligator clips after the clips have cooled.



Detail 10-8C

This completes the "Step-by-Step Assembly" of your Oscilloscope. Check it over carefully at this time to be sure there are no wire clippings or solder splashes lodged in the wiring, and that there are no loose wires or unsoldered connections. Then proceed to "Initial Tests."



PICTORIAL 10-8

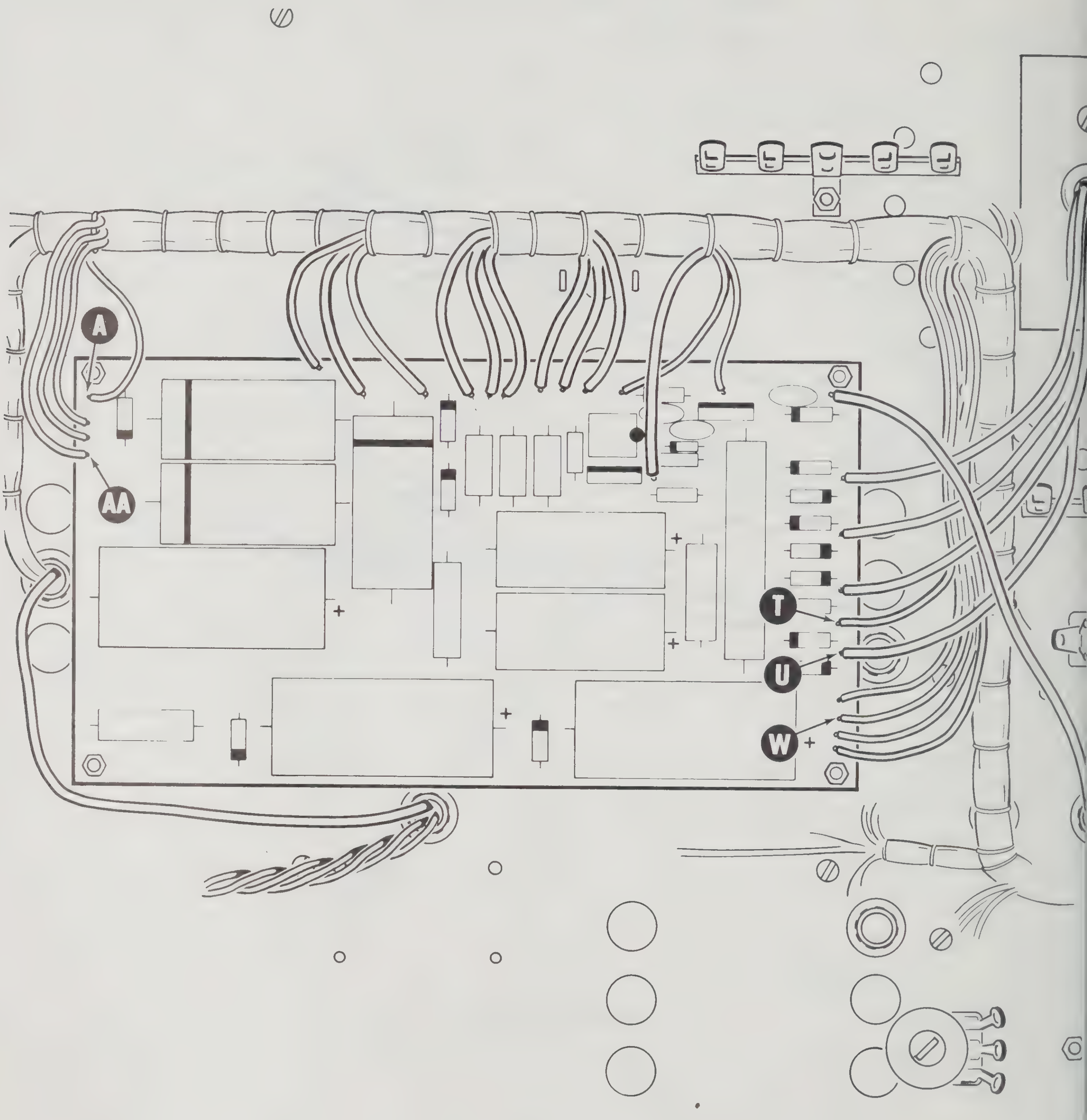


Figure 1-1

INITIAL TESTS

RESISTANCE MEASUREMENTS

( ) If an ohmmeter is available, measure the resistance between each flat plug prong and the round prong on the line cord. In both measurements you should obtain an infinite indication. Be sure the test probe is not touching the chassis or any connection.

If you do not obtain infinite indications, recheck all wiring and make sure no fine wire strands at any connection are touching another connection.

Use an ohmmeter to make the following resistance measurements before you apply power to the Oscilloscope. This will insure that the power supply will not be damaged due to a wiring error or some incorrectly installed or faulty part. If you do not get the proper indication in a step, check the wiring and installation of the parts listed in the "Possible Cause" column for that step. You may also refer to the "In Case of Difficulty" section of the Manual (Page 129). Be sure you obtain the correct resistance reading before proceeding.

Refer to Figure 1-1 for the following steps.

(✓) Position the Oscilloscope bottom side up.

(✓) Connect the negative ohmmeter lead to the chassis of the Oscilloscope. Then touch the positive meter lead to the points indicated in the following chart.

NOTE: Not all ohmmeters are polarized the same. Therefore, if you do not get the correct meter reading the first time, connect the positive meter lead to the chassis and touch the negative meter lead to the point indicated in the chart. If this produces the correct indication, cross out the word "positive" in the heading of the first column and write in "negative."

NOTE: The ohmmeter that was used to make the following measurements was powered by a 1.5 volt battery and set on the RX100 range.

Make all of the following measurements on the power supply circuit board.

POSITIVE METER LEAD TO:	APPROXIMATE METER READING	POSSIBLE CAUSE
(✓) White wire at hole T.	700-1200 Ω	1. Capacitor C25. 2. Check power supply wiring, especially around C25. 3. Transformer T2. 4. Diodes D404,D405,D406, and D407.
(✓) Red wire at hole U.	1000-4000 Ω	
(✓) Orange wire at hole W.	500-1000 Ω	1. Capacitor C407, C408, C409, C411, or C412. 2. Diodes ZD413,ZD414,ZD415,D408, D409,D410, or D411.
(✓) Violet wire at hole AA.	50-300 Ω	1. Capacitor C408. 2. Diode ZD414,D408,D409,D410, or D411. 3. Resistor R409.
(✓) Green wire at hole A.	500-1000 Ω	1. Capacitor C409 or C411. 2. Diode ZD413.

This completes the Initial Tests. Proceed to "Calibration."

CALIBRATION

In this section you will set the circuit board and front panel controls of your Oscilloscope for proper operation. To do this you will need a high input impedance voltmeter. Perform the adjustments exactly as instructed and DO NOT connect the line cord to an AC outlet until you are instructed to do so.

Equipment needed: High input impedance voltmeter.

Refer to Figure 1-2 in the Illustration Booklet for the following steps.

Set the front panel controls as follows:

(X) INTENSITY: Full clockwise.

(X) FOCUS: Center of rotation.

(X) TRIG LEVEL: Center of rotation.

(X) HORIZ POS: Center of rotation.

(X) TIME/CM: X10.

(X) SWEEP VAR/HORIZ GAIN: Full clockwise.

(X) VOLTS/CM: .02.

(X) VARIABLE: Full clockwise.

(X) VERT POS: Center of rotation.

(X) AC-GND-DC: GND.

(X) OFF-ON switch: OFF.

(X) INT-EXT-LINE switch: INT.

(X) AC-DC-TV switch: AC.

(X) POSITIVE (+) NEGATIVE (–) switch: +.

(X) AUTO-NORMAL switch: AUTO.

(X) Set the ASTIGMATISM control on the chassis (see Figure 1-3 in the Illustration Booklet) to the center of its rotation.

Set the following controls on the vertical amplifier circuit board as follows:

(X) DC LEVEL: Center of rotation.

(X) POS ADJ: Center of rotation.

(X) PLATE VOLTS ADJ: Center of rotation.

(X) VERT CAL: Center of rotation.

(X) DC BAL: Center of rotation.

(X) TRIMMER C107: Turn the screw down until it is snug. Then turn the screw counterclockwise 3/4 of a turn.

Set the following controls on the horizontal amplifier circuit board as follows:

(✓) SWEEP LENGTH: Center of rotation.

(✓) PLATES VOLTS ADJ: Center of rotation.

(✓) DC BAL: Center of rotation.

Set the following controls on the sweep-trigger circuit board as follows:

(✓) SWEEP CALIBRATE: Center of rotation.

(✓) LEVEL SET: Center of rotation.

CAUTION: AC and DC voltages in some areas of the Oscilloscope may exceed 1300 volts. Be very careful when you make the following adjustments. Make sure the Oscilloscope is setting on a nonmetallic surface and is not within reach of a water pipe or other ground conductor. The dangerous voltage areas are shown on Pages 150 and 151.

(✓) Connect the Oscilloscope line cord to an AC outlet.

(✓) Connect the negative voltmeter lead to the chassis of the Oscilloscope.

(✓) Set the voltmeter to measure 1.5 volts DC.

NOTE: If you do not get the proper results in the following steps, recheck the steps to make sure you have adjusted the correct controls. If you still do not get the indicated results, turn the Oscilloscope off and refer to the "In Case of Difficulty" section on Page 129.

(✓) Set the ON-OFF switch on the Oscilloscope to the ON position. The red POWER lamp should light. Allow the Oscilloscope at least one minute to warm up.

VERTICAL AMPLIFIER ADJUSTMENTS

Perform the following adjustments on the vertical amplifier circuit board.

Refer to Figure 1-3 for the following steps.

(✓) Touch the meter probe to the front lug of the VERT CAL control and adjust the DC BAL (DC Balance) control to obtain a zero volt reading.

(✓) Set the voltmeter to measure 150 volts DC.

(✓) Alternately measure the voltage on the metal tab on top of transistor Q109 and Q110. Adjust the POS ADJ (Position Adjust) control until both transistor voltages are the same. (As the voltage on one transistor decreases, the voltage on the other transistor will increase.) NOTE: If you cannot quite achieve this adjustment using the POS ADJ control on the circuit board, turn the VERT POS control on the front panel.

(✓) Again measure the voltage on the metal tab on top of transistors Q109 and Q110. Turn the PLATE VOLTS ADJ control to obtain 80 volts on the metal tabs. NOTE: If the voltage on both transistor tabs is not the same, repeat the previous step and then return to this step.

Vertical Balance Adjustment

(✓) Turn the VARIABLE control on the front panel full counterclockwise.

(✓) Using the VERT POS (Vertical Position) control on the front panel, position the dot on the CRT so it is on one of the horizontal graticule lines.

(✓) Now turn the VARIABLE control full clockwise. If the dot moved up or down, adjust the DC BAL control on the vertical amplifier circuit board to reposition the dot back on the line.

(✓) Repeat the previous three steps until there is no movement.

NOTE: Because of the normal ageing of your Oscilloscope, you may have to repeat this adjustment periodically. To determine if the adjustment is necessary, turn the VARIABLE control from one end to the other and see if the dot or trace moves up or down. The trace should remain in the same place.

HORIZONTAL AMPLIFIER ADJUSTMENTS

Perform the following adjustments on the horizontal amplifier circuit board.

(X) Set the voltmeter to measure 1.5 volts DC.

Refer to Figure 1-3 (in the Illustration Booklet) for the following steps.

(X) Touch the meter probe to the collector (C) lead of transistor Q202 and adjust the DC BAL (DC Balance) control to obtain a zero volt reading.

(X) Set the voltmeter to measure 150 volts.

(X) Alternately measure the voltage on the metal tab on top of transistors Q207 and Q208. Adjust the HORIZ POS (Horizontal Position) control on the front panel until they are equal. NOTE: As the voltage on one transistor decreases, the voltage on the other transistor will increase.

(X) Again measure the voltage on the metal tab on top of transistors Q207 and Q208. Turn the PLATE VOLTS ADJ control to obtain 90 volts on the metal tabs. NOTE: If the voltage on both transistor tabs is not the same, repeat the previous step and then return to this step.

Horizontal Balance Adjustment

(X) Turn the SWEEP VAR/HORIZ GAIN control full counterclockwise.

(X) Using the HORIZ POS (Horizontal Position) control on the front panel, position the dot on the CRT so it is on one of the vertical graticule lines.

(X) Now turn the SWEEP VAR/HORIZ GAIN control full clockwise. If the dot moves left or right, adjust the DC BAL control on the horizontal amplifier circuit board to reposition the dot back on the line.

(X) Repeat the previous three steps until there is no movement.

NOTE: Becuase of the normal ageing of your Oscilloscope, you may have to repeat this adjustment periodically. To determine if the adjustment is necessary, turn the SWEEP VAR/HORIZ GAIN control from one end to the other and see if the dot or trace moves up or down. The trace should remain in the same place.

TRIGGER CIRCUITS

Make the following adjustments on the front panel.

Refer to Figure 1-2 for the following steps.

(X) Turn the FOCUS control to obtain the smallest, sharpest spot of light on the CRT.

(X) Turn the ASTIGMATISM control on the chassis (see Figure 1-3) to obtain the smallest, sharpest spot of light on the CRT.

(X) Set the TIME/CM selector to the 2 mS position.

(X) Make sure that the VARIABLE control on the TIME/CM selector is turned fully clockwise.

Refer to Figure 1-3 (in the Illustration Booklet) for the following steps.

(X) Set the voltmeter to measure 1.5 volts DC.

(X) Touch the meter probe to the S (source) lead of transistor Q301 on the sweep-trigger circuit board and turn the LEVEL SET control to obtain a zero volt reading.

(X) Disconnect the voltmeter and set it aside.

(X) Inspect the trace on the CRT to see if it is parallel with the horizontal lines on the graticule. If it is, proceed to step 2. If the trace is not parallel to the graticule lines, complete all of the following steps.

1. (X) Grasp the CRT just back from the front panel and turn the tube to make the trace parallel with the graticule lines.

2. (X) Make sure the CRT is positioned all the way forward. Then tighten the CRT clamp screws. Tighten these screws only enough to keep the CRT from moving.

(✓) Adjust the HORIZ POS control on the front panel so the trace starts at the left vertical line of the graticule.

( ) Adjust the SWEEP LENGTH control on the horizontal amplifier circuit board so that the trace ends at the right vertical line of the graticule (10 centimeters long).

( ) Now turn the HORIZ POS control on the front panel so that the trace moves left exactly two centimeters. (Each square is a centimeter.) At this time the trace should end on a vertical line two centimeters from the right side of the graticule.

( ) Again, adjust the SWEEP LENGTH control on the horizontal amplifier circuit board so that the trace ends at the right vertical line of the graticule.

( ) Adjust the HORIZ POS control on the front panel so the trace starts at the left vertical line on the graticule. The trace is now adjusted to exactly 12 centimeters in length. However, since there is only room to display 10 centimeters of trace on the face of the CRT, the other two centimeters of trace are off the CRT to the right.

( ) Connect a wire from the 1V (P-P) 60 Hz jack on the front panel to the vertical INPUT on the front panel of the Oscilloscope, or if you have a signal generator capable of producing a 60 Hz sine wave, connect it to the vertical INPUT.

( ) Set the TIME/CM selector to the 2 mS position.

( ) Set the VOLTS/CM (volts per centimeter) control on the front panel to the 1 position. Make sure that the VARIABLE control remains fully clockwise.

( ) Set the AC-GND-DC switch to AC.

NOTE: In the next step it is not necessary to have the full sine wave displayed on the CRT. Only the leading part of the trace (on the left side of the CRT) will be used in this adjustment.

( ) Set the amplitude of the generator to produce a 6 centimeter vertical display on the CRT. NOTE: If you are using the 1V (P-P) 60 Hz jack on the front panel, disregard this step.

( ) Adjust the TRIG LEVEL (trigger level) control on the front panel to obtain a stable display.

( ) Center the display on the CRT by adjusting the VERT POS control.

( ) Now adjust the TRIG LEVEL control to obtain a trace that starts on the center horizontal line. (Make sure the display is centered on the CRT.)

( ) Set the AC-DC-TV switch to DC.

( ) Adjust the DC LEVEL control on the vertical amplifier circuit board to obtain a stable display with a trace that begins on the center horizontal line on the CRT.

( ) Now switch the AC-DC-TV switch back and forth between the AC and DC positions. The display should remain stable and the trace should begin at the same place in both positions. Repeat the DC LEVEL adjustment if necessary.

Trimmer Preset

Refer to Figure 1-5 (in the Illustration Booklet) for the following steps.

( ) Disconnect the line cord from the AC outlet.

( ) Position the Oscilloscope on its right side (transformer cage side) for the following steps.

NOTE: In the following steps, you must insert the screwdriver through the holes in the shield to reach the trimmer screws.

( ) Turn the screw in trimmer C2-A out exactly 3/4 turn.

( ) Turn the screw in trimmer C2-B out exactly 3/4 turn.

( ) Turn the screw in trimmer C2-C out exactly 3/4 turn.

Trigger Circuits Continued

NOTE: To complete the following calibration procedure, you will need a signal generator capable of producing 500 Hz sine waves and square waves at 500 Hz, 1000 Hz, and 100 kHz, or an oscilloscope calibrator. If you do not have such a generator, proceed to "Final Assembly."

( ) Position the Oscilloscope right-side-up. Then reconnect the line cord to the AC outlet.

( ) Connect the signal generator or oscilloscope calibrator to the vertical INPUT of the Oscilloscope (if it is not already connected), and set it to produce a 500 Hz square wave. NOTE: If your oscilloscope calibrator is not capable of producing 500 Hz, use 1000 Hz.

NOTE: In the following steps, the term "signal generator" will also apply to your oscilloscope calibrator if you are using one.

( ) Adjust the output of your signal generator to obtain a 4-centimeter vertical display.

( ) Adjust the SWEEP CAL (sweep calibrate) control on the sweep-trigger circuit board to obtain a one-cycle-per-centimeter display on the CRT. Make sure you include the upper and lower part of the square wave. NOTE: If you are using 1000 Hz as your generator frequency, adjust the control to obtain two cycles per centimeter.

( ) Set the signal generator to produce a 500 Hz sine wave. If your generator will not produce a sine wave, place the AC-GND-DC switch on the Oscilloscope in the GND position.

( ) Adjust the transformer cage (by turning it) for the sharpest, clearest trace on the CRT.

( ) Turn the Oscilloscope off, disconnect the signal generator, and disconnect the line cord from the AC outlet.

( ) Turn the Oscilloscope over.

( ) Refer to Figure 1-4 in the Illustration Booklet and move the transformer cage so that a screw hole in the cage lines up with a hole in the chassis. Then install a 6-32 x 1/4" hex head sheet metal screw in the hole to keep the transformer cage from moving. Also tighten the four screws in the grommet plate.

( ) Turn the Oscilloscope over and connect the line cord to an AC outlet.

VERTICAL COMPENSATION

( ) Connect the signal generator to the vertical INPUT on the front of the Oscilloscope.

( ) Set the signal generator to produce a 100 kHz square wave.

( ) Set the VOLTS/CM selector on the front panel to the .1 position.

( ) Turn the Oscilloscope on.

( ) Set the TIME/CM selector to 2 μS.

( ) Adjust the signal generator to produce a 4-centimeter display.

( ) Turn the screw in the VERTICAL COMPENSATION trimmer (C107) on the vertical amplifier circuit board (see Figure 1-3) until the waveform appears as shown in Figure 1-6 (shown in the Illustration Booklet).

( ) Set the VOLTS/CM selector to the 1 position.

( ) Set the TIME/CM switch to 200 μS.

( ) Set the signal generator to produce a 1000 Hz square wave.

( ) Set the amplitude of the signal generator to produce a 4-centimeter display.

( ) Disconnect the line cord from the AC outlet and position the Oscilloscope on its left side. Then reconnect the line cord.

( ) Turn the screw in trimmer C2-B (see Figure 1-7 in the Illustration Booklet) to obtain a waveform that appears like the one shown in Figure 1-6. Use an insulated screwdriver.

( ) Turn the VOLTS/CM switch to the 2 position.

( ) If possible, increase the amplitude of the signal generator to produce a 4-centimeter display on the CRT.

( ) Turn the screw in trimmer C2-C to obtain a waveform that appears like the one shown in Figure 1-6.

( ) Repeat all of the "Vertical Compensation" adjustments until there is no further improvement.

NOTE: If you have a low capacity probe, perform the following steps under "With Low Capacity Probe." If you do not have a low capacity probe, disregard the following steps and proceed to "Without Low Capacity Probe."

With Low Capacity Probe

( ) Connect the low capacity probe to the vertical INPUT on the Oscilloscope and to the signal generator.

( ) Set the signal generator to produce a 1000 Hz square wave signal to the Oscilloscope.

( ) Turn the VOLTS/CM selector on the Oscilloscope to the .02 position.

( ) Set the amplitude of the signal generator to produce a 4 centimeter vertical display on the CRT.

( ) Adjust the trimmer capacitor on the X10 low capacity probe to produce a waveform as shown in Figure 1-6.

( ) Turn the VOLTS/CM selector to the .2 position.

( ) If possible, increase the amplitude of the signal generator to produce a vertical display of 4 centimeters.

( ) Refer to Figure 1-7 and turn the screw in trimmer C2-A to produce a waveform as shown in Figure 1-6.

( ) Disconnect the low capacity probe and reconnect the signal generator to the vertical INPUT.

This completes the low capacity probe adjustment. Proceed to "Vertical Calibration."

Without Low Capacity Probe

( ) Refer to Figure 1-7 and turn the screw in trimmer C2-A in until it is just snug. Be careful that you do not overtighten the screw. Then turn the screw out 1/4 turn.

VERTICAL CALIBRATION

( ) Set the TIME/CM selector to the 2 mS position.

( ) Set the VOLTS/CM selector to the 0.2 position. Make sure the VARIABLE is full clockwise.

( ) Set the signal generator or oscilloscope calibrator to produce a IV(P-P), 60 Hz waveform. If your generator output is not calibrated or cannot be measured, connect instead a wire from the IV(P-P), 60 Hz jack on the Oscilloscope front panel to the vertical INPUT connector.

( ) Set the AC-GND-DC switch to AC.

( ) Adjust the SWEEP VAR/HORIZ GAIN (Sweep Variable/Horizontal Gain) control to produce several cycles on the CRT.

( ) Refer to Figure 1-3 and turn the VERT CAL (Vertical Calibration) control, on the vertical amplifier circuit board, to obtain 5 centimeters of vertical deflection.

( ) Turn the Oscilloscope off and disconnect the line cord from the AC outlet.

( ) Disconnect the signal generator from the Oscilloscope.

NOTE: It is suggested that you repeat the "Calibration" after your Oscilloscope has operated several hours, and periodically thereafter. Each time, allow sufficient warm-up time (at least 30 minutes) before you start calibration.

This completes the calibration. Proceed to "Final Assembly."

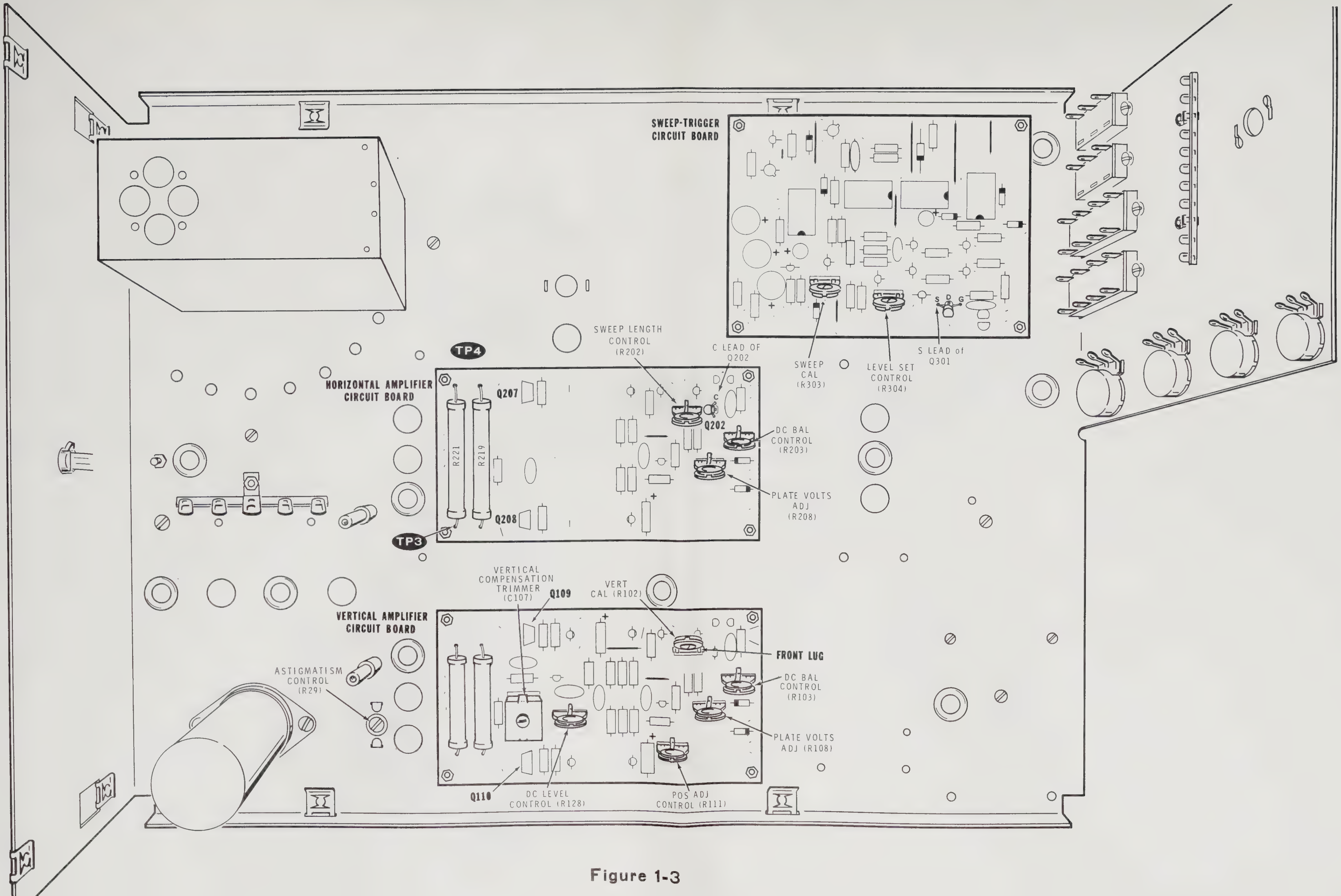

SWEEP-TRIGGER
CIRCUIT BOARD
SWEEP LENGTH
CONTROL
(R202)
C LEAD OF
Q202
C
S D G
SWEEP
CAL
(R303)
LEVEL SET
CONTROL
(R304)
S LEAD of
Q301
TP4
HORIZONTAL AMPLIFIER
CIRCUIT BOARD
Q207
Q202
DC BAL
CONTROL
(R203)
R221
R219
PLATE VOLTS
ADJ
(R208)
Q208
TP3
VERTICAL
COMPENSATION
TRIMMER
(C107)
Q109
VERT
CAL (R102)
VERTICAL AMPLIFIER
CIRCUIT BOARD
FRONT LUG
ASTIGMATISM
CONTROL
(R29)
DC BAL
CONTROL
(R103)
PLATE VOLTS
ADJ (R108)
Q110
DC LEVEL
CONTROL (R128)
POS ADJ
CONTROL (R111)

Figure 1-3

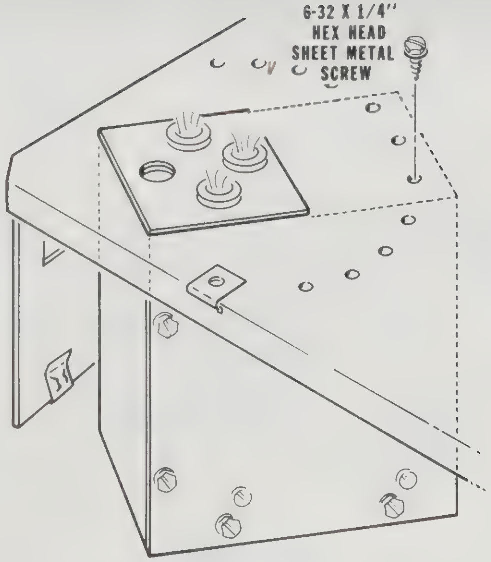


Figure 1-4

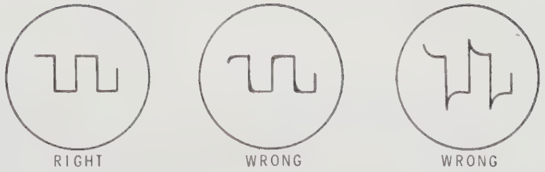


Figure 1-6

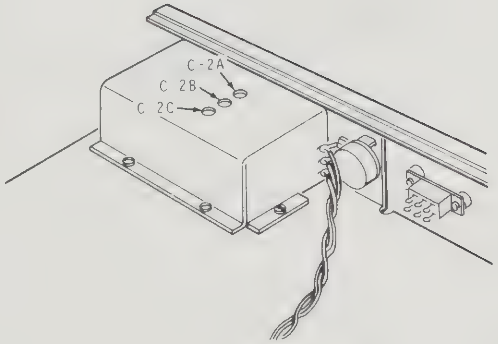


Figure 1-5

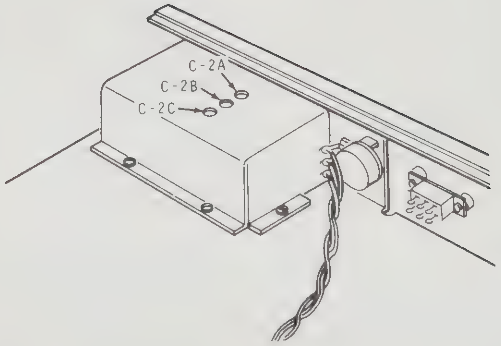
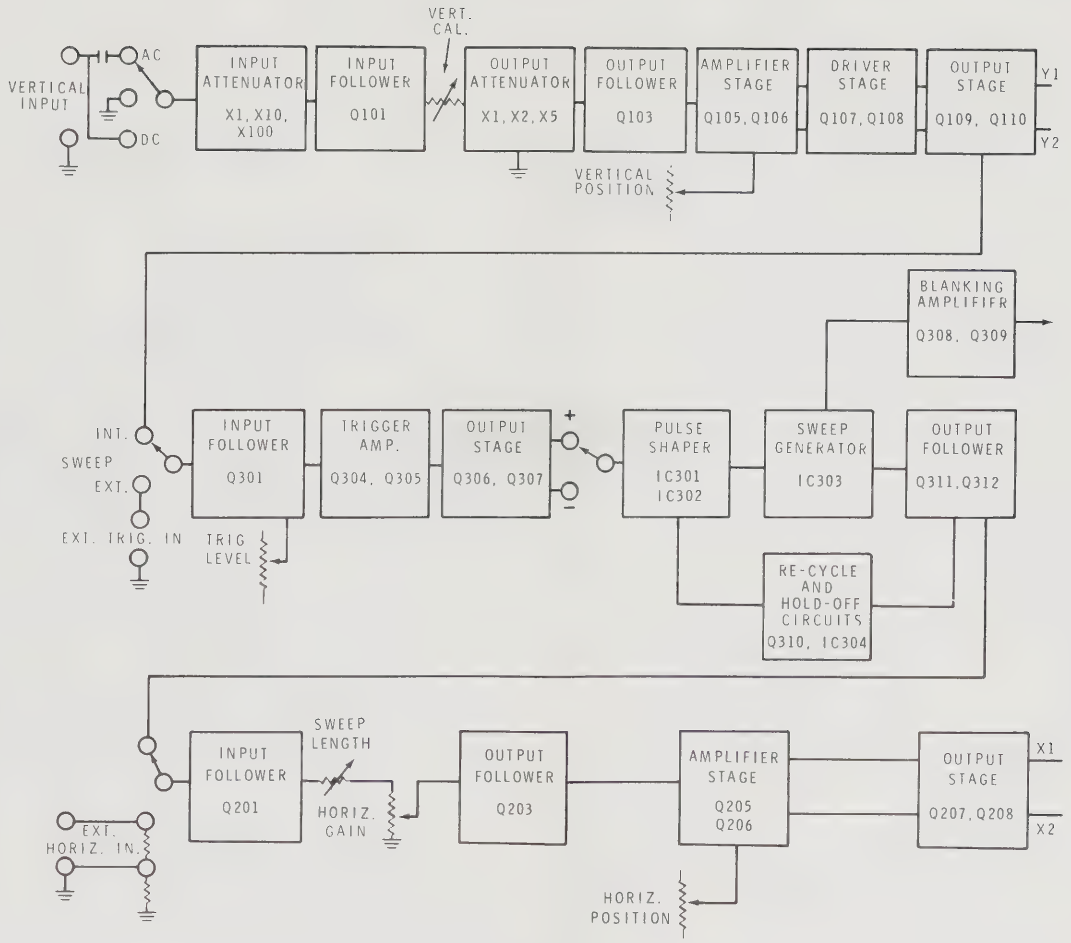


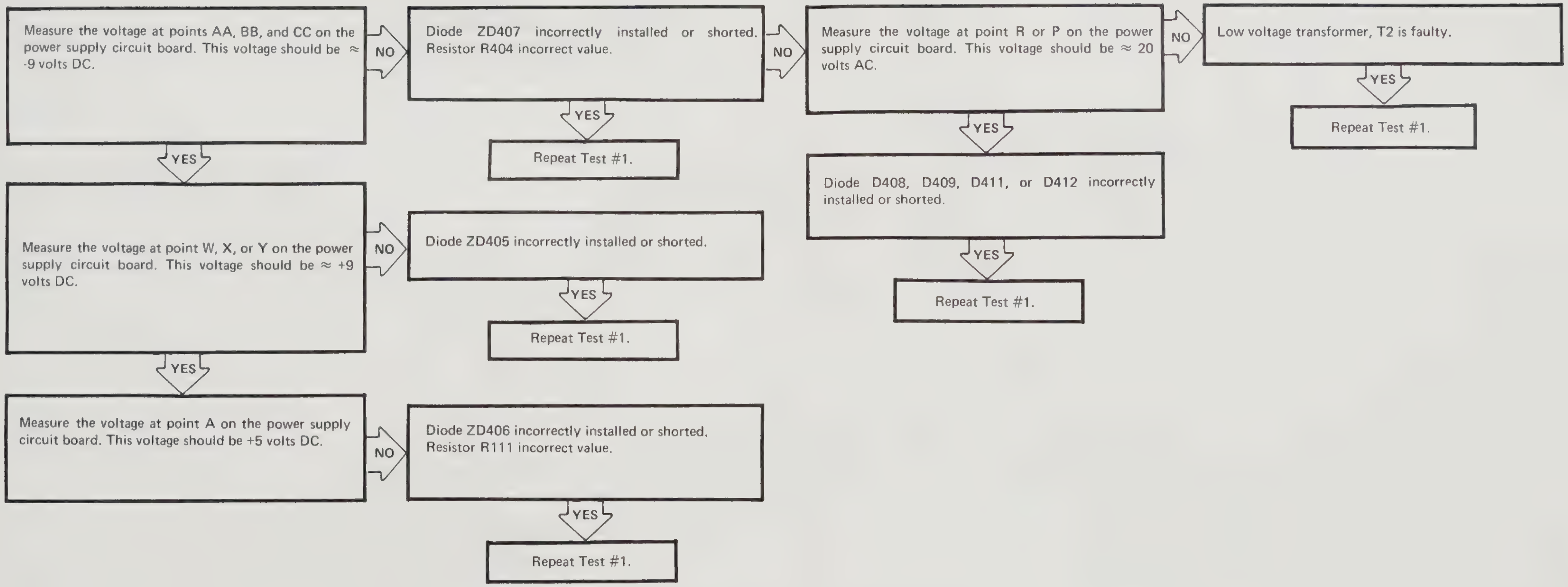
Figure 1-7



BLOCK DIAGRAM

TEST #1

+9, +5 VOLTS POWER SUPPLY



Measure the voltage at points AA, BB, and CC on the power supply circuit board. This voltage should be ≈ -9 volts DC.

Diode ZD407 incorrectly installed or shorted. Resistor R404 incorrect value.

Repeat Test #1.

Measure the voltage at point R or P on the power supply circuit board. This voltage should be ≈ 20 volts AC.

Low voltage transformer, T2 is faulty.

Repeat Test #1.

Diode D408, D409, D411, or D412 incorrectly installed or shorted.

Repeat Test #1.

Measure the voltage at point W, X, or Y on the power supply circuit board. This voltage should be ≈ +9 volts DC.

Diode ZD405 incorrectly installed or shorted.

Repeat Test #1.

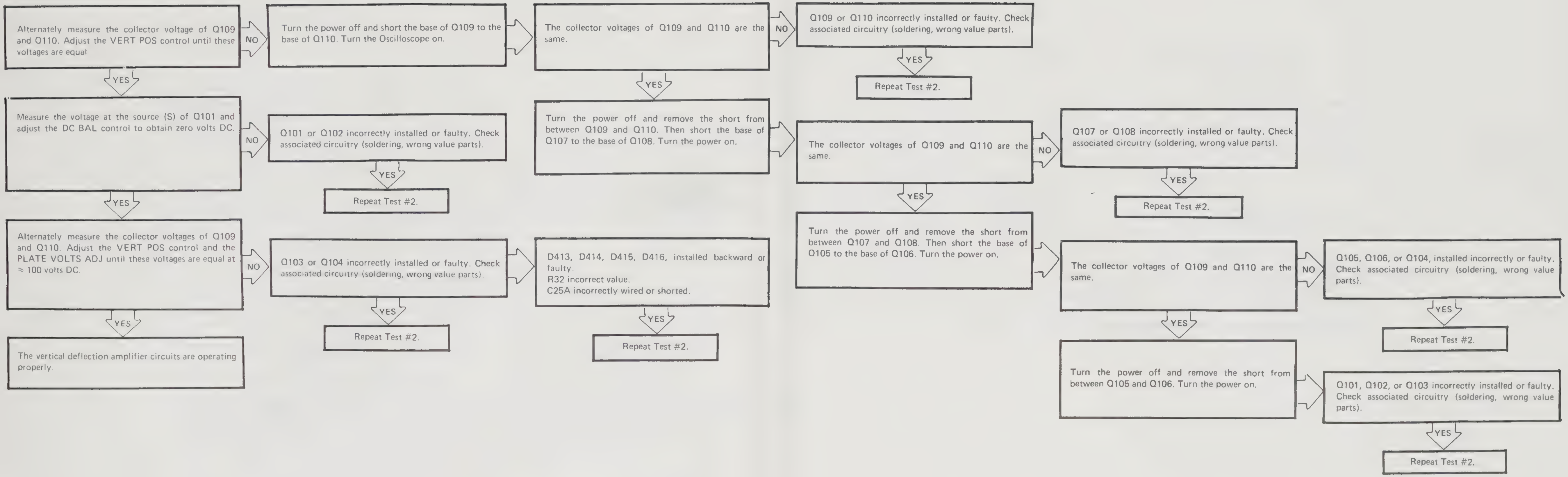
Measure the voltage at point A on the power supply circuit board. This voltage should be +5 volts DC.

Diode ZD406 incorrectly installed or shorted. Resistor R111 incorrect value.

Repeat Test #1.

TEST #2

VERTICAL DEFLECTOR AMPLIFIER



Alternately measure the collector voltage of Q109 and Q110. Adjust the VERT POS control until these voltages are equal

Turn the power off and short the base of Q109 to the base of Q110. Turn the Oscilloscope on.

The collector voltages of Q109 and Q110 are the same.

Q109 or Q110 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #2.

Measure the voltage at the source (S) of Q101 and adjust the DC BAL control to obtain zero volts DC.

Q101 or Q102 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #2.

Turn the power off and remove the short from between Q109 and Q110. Then short the base of Q107 to the base of Q108. Turn the power on.

The collector voltages of Q109 and Q110 are the same.

Q107 or Q108 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #2.

Alternately measure the collector voltages of Q109 and Q110. Adjust the VERT POS control and the PLATE VOLTS ADJ until these voltages are equal at ≈ 100 volts DC.

Q103 or Q104 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #2.

D413, D414, D415, D416, installed backward or faulty.
R32 incorrect value.
C25A incorrectly wired or shorted.

Repeat Test #2.

Turn the power off and remove the short from between Q107 and Q108. Then short the base of Q105 to the base of Q106. Turn the power on.

The collector voltages of Q109 and Q110 are the same.

Q105, Q106, or Q104, installed incorrectly or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #2.

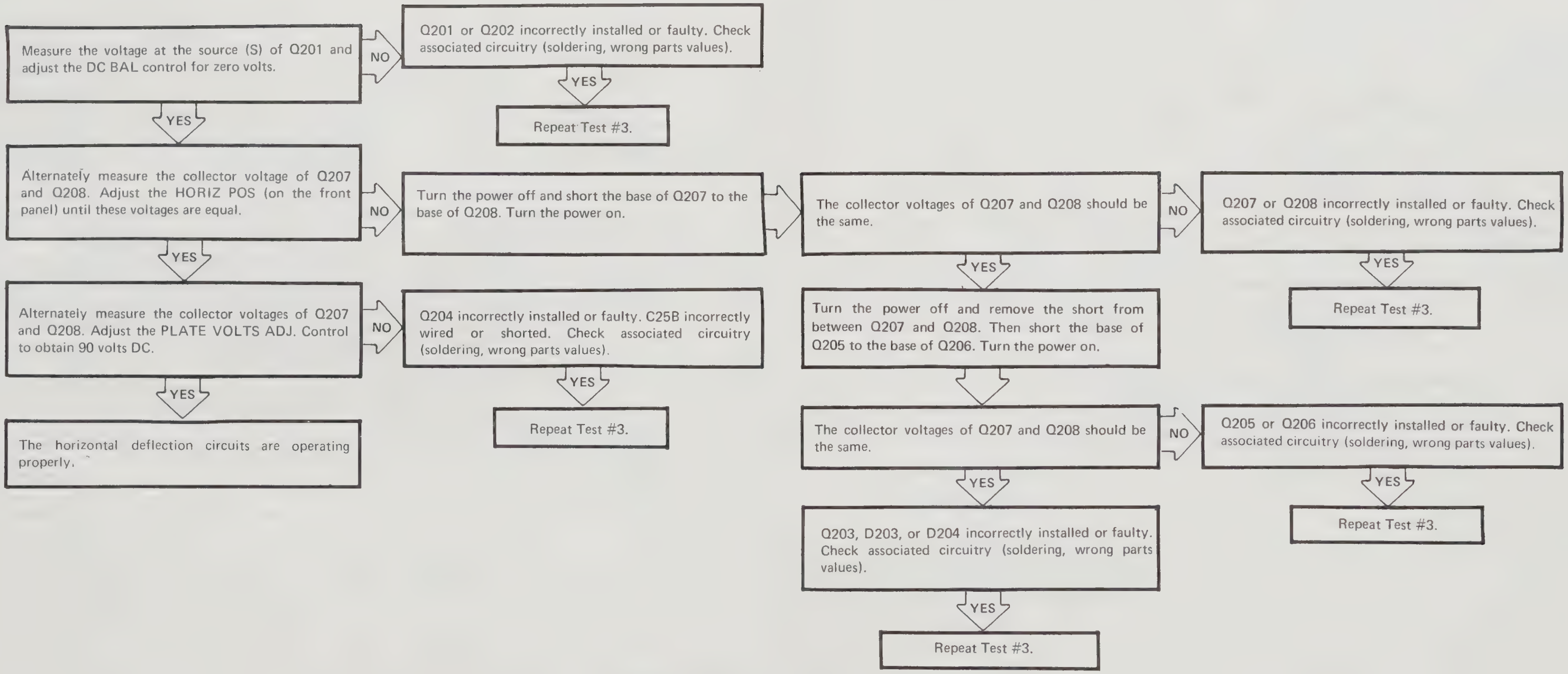
The vertical deflection amplifier circuits are operating properly.

Turn the power off and remove the short from between Q105 and Q106. Turn the power on.

Q101, Q102, or Q103 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #2.

TEST #3
HORIZONTAL DEFLECTION AMPLIFIER



Measure the voltage at the source (S) of Q201 and adjust the DC BAL control for zero volts.

Q201 or Q202 incorrectly installed or faulty. Check associated circuitry (soldering, wrong parts values).

Repeat Test #3.

Alternately measure the collector voltage of Q207 and Q208. Adjust the HORIZ POS (on the front panel) until these voltages are equal.

Turn the power off and short the base of Q207 to the base of Q208. Turn the power on.

The collector voltages of Q207 and Q208 should be the same.

Q207 or Q208 incorrectly installed or faulty. Check associated circuitry (soldering, wrong parts values).

Repeat Test #3.

Turn the power off and remove the short from between Q207 and Q208. Then short the base of Q205 to the base of Q206. Turn the power on.

The collector voltages of Q207 and Q208 should be the same.

Q205 or Q206 incorrectly installed or faulty. Check associated circuitry (soldering, wrong parts values).

Repeat Test #3.

Q203, D203, or D204 incorrectly installed or faulty. Check associated circuitry (soldering, wrong parts values).

Repeat Test #3.

Alternately measure the collector voltages of Q207 and Q208. Adjust the PLATE VOLTS ADJ. Control to obtain 90 volts DC.

Q204 incorrectly installed or faulty. C25B incorrectly wired or shorted. Check associated circuitry (soldering, wrong parts values).

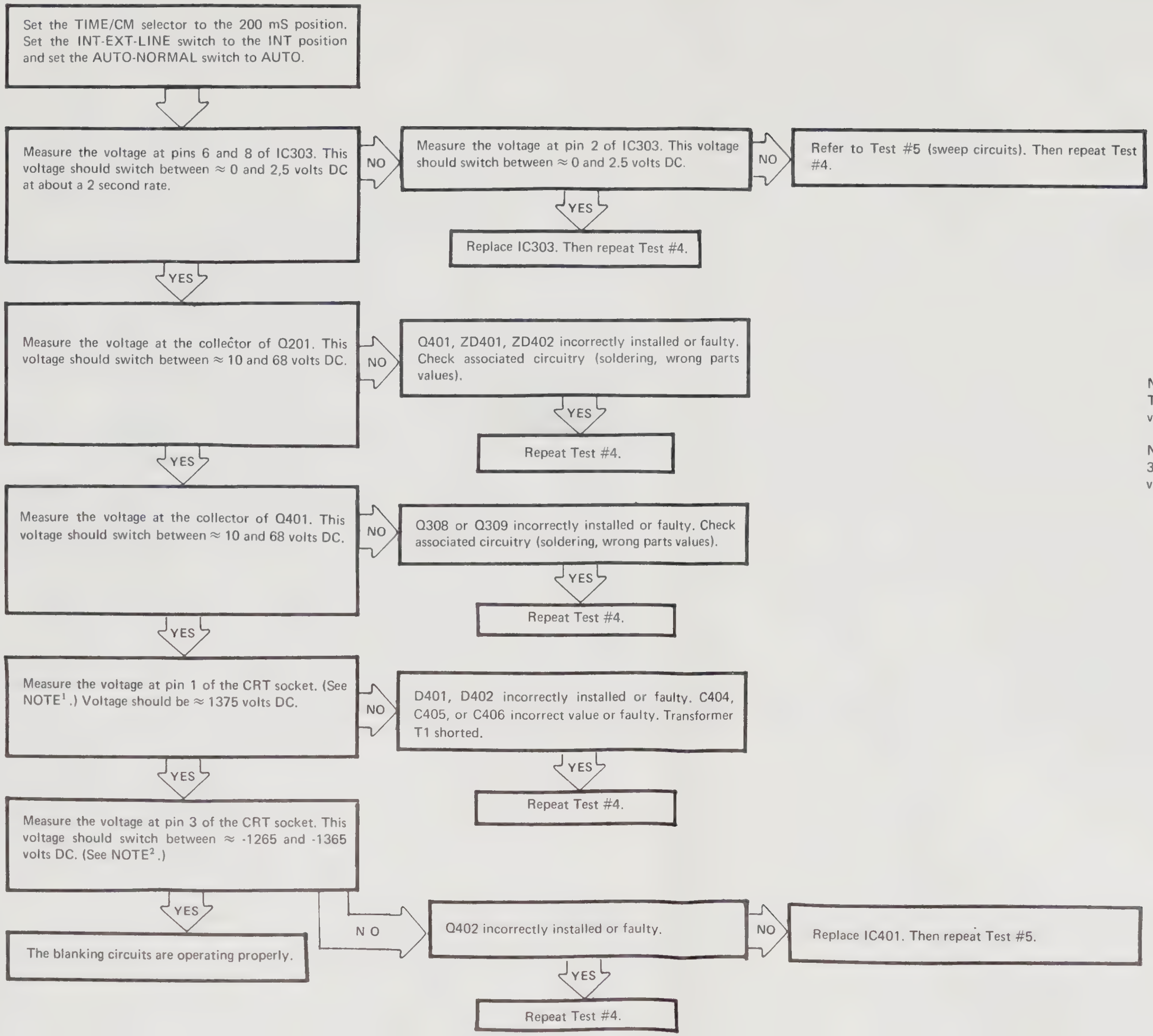
Repeat Test #3.

The horizontal deflection circuits are operating properly.

TEST #4

BLANKING CIRCUIT

CAUTION: You will be making voltage measurements in the high voltage area of the Oscilloscope. Be very careful not to contact this high voltage. See Page 151.



Set the TIME/CM selector to the 200 mS position. Set the INT-EXT-LINE switch to the INT position and set the AUTO-NORMAL switch to AUTO.

Measure the voltage at pins 6 and 8 of IC303. This voltage should switch between ≈ 0 and 2,5 volts DC at about a 2 second rate.

Measure the voltage at pin 2 of IC303. This voltage should switch between ≈ 0 and 2.5 volts DC.

Refer to Test #5 (sweep circuits). Then repeat Test #4.

Replace IC303. Then repeat Test #4.

Measure the voltage at the collector of Q201. This voltage should switch between ≈ 10 and 68 volts DC.

Q401, ZD401, ZD402 incorrectly installed or faulty. Check associated circuitry (soldering, wrong parts values).

Repeat Test #4.

Measure the voltage at the collector of Q401. This voltage should switch between ≈ 10 and 68 volts DC.

Q308 or Q309 incorrectly installed or faulty. Check associated circuitry (soldering, wrong parts values).

Repeat Test #4.

Measure the voltage at pin 1 of the CRT socket. (See NOTE[1].) Voltage should be ≈ 1375 volts DC.

D401, D402 incorrectly installed or faulty. C404, C405, or C406 incorrect value or faulty. Transformer T1 shorted.

Repeat Test #4.

Measure the voltage at pin 3 of the CRT socket. This voltage should switch between ≈ -1265 and -1365 volts DC. (See NOTE[2].)

The blanking circuits are operating properly.

Q402 incorrectly installed or faulty.

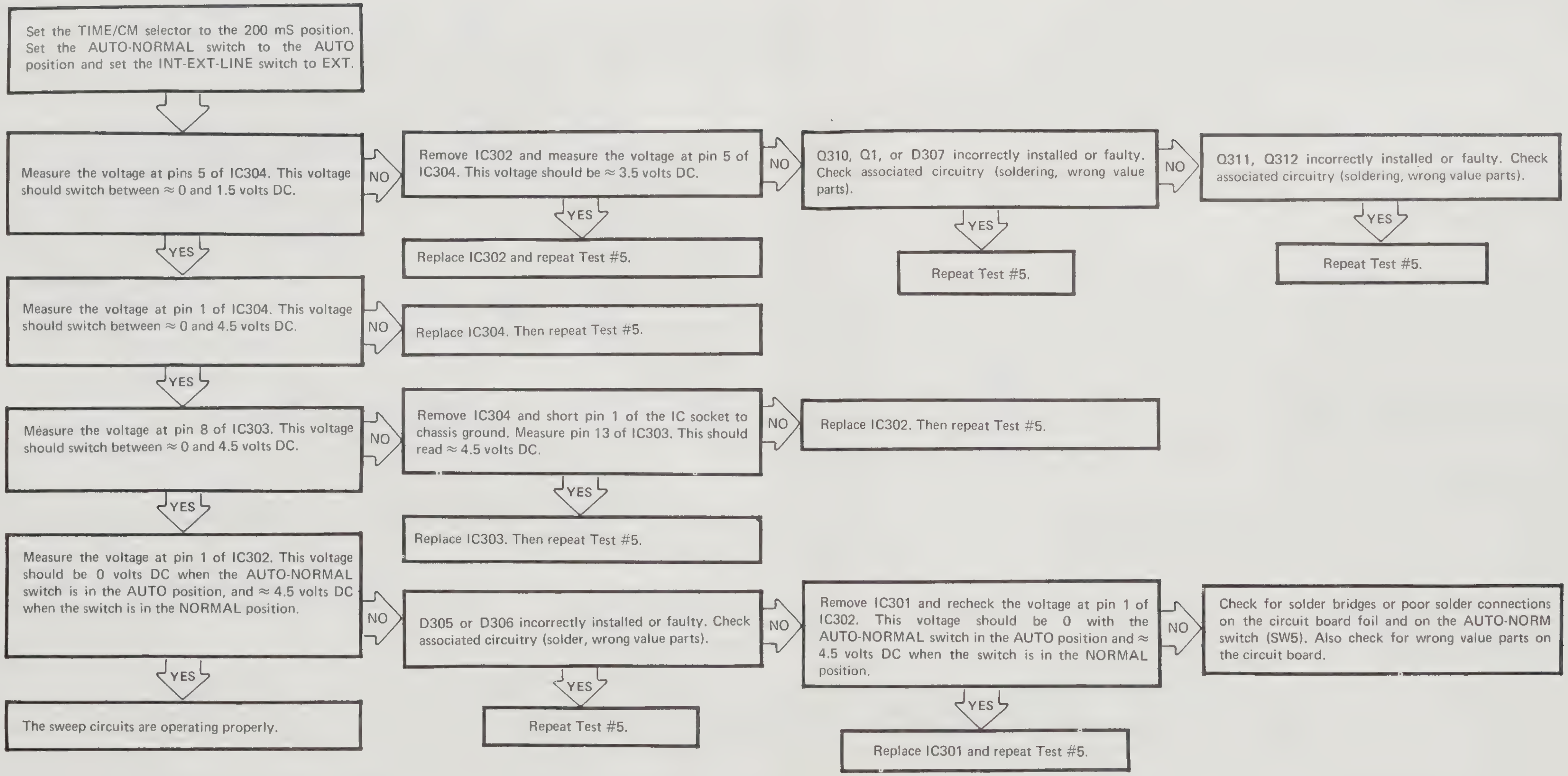
Replace IC401. Then repeat Test #5.

Repeat Test #4.

NOTE[1]: Hi voltage is dependent on the line voltage. This will be ≈ -1375 when the line voltage is 120 volts AC.

NOTE[2]: There will be about a 100 volt change at pin 3 with respect to the power supply voltage and a 70 volt change at pin 2.

TEST#5
SWEEP CIRCUITS



Set the TIME/CM selector to the 200 mS position. Set the AUTO-NORMAL switch to the AUTO position and set the INT-EXT-LINE switch to EXT.

Measure the voltage at pins 5 of IC304. This voltage should switch between ≈ 0 and 1.5 volts DC.

Remove IC302 and measure the voltage at pin 5 of IC304. This voltage should be ≈ 3.5 volts DC.

Replace IC302 and repeat Test #5.

Q310, Q1, or D307 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #5.

Q311, Q312 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #5.

Measure the voltage at pin 1 of IC304. This voltage should switch between ≈ 0 and 4.5 volts DC.

Replace IC304. Then repeat Test #5.

Measure the voltage at pin 8 of IC303. This voltage should switch between ≈ 0 and 4.5 volts DC.

Remove IC304 and short pin 1 of the IC socket to chassis ground. Measure pin 13 of IC303. This should read ≈ 4.5 volts DC.

Replace IC302. Then repeat Test #5.

Replace IC303. Then repeat Test #5.

Measure the voltage at pin 1 of IC302. This voltage should be 0 volts DC when the AUTO-NORMAL switch is in the AUTO position, and ≈ 4.5 volts DC when the switch is in the NORMAL position.

D305 or D306 incorrectly installed or faulty. Check associated circuitry (solder, wrong value parts).

Repeat Test #5.

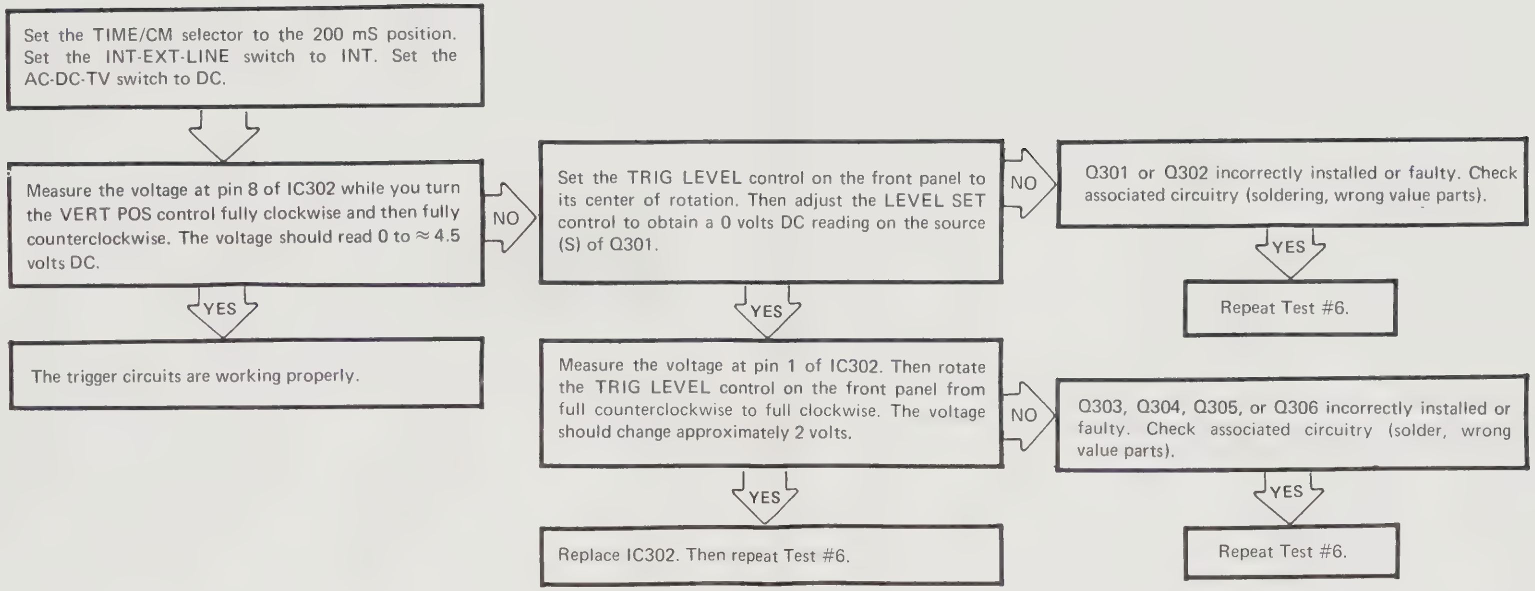
Remove IC301 and recheck the voltage at pin 1 of IC302. This voltage should be 0 with the AUTO-NORMAL switch in the AUTO position and ≈ 4.5 volts DC when the switch is in the NORMAL position.

Replace IC301 and repeat Test #5.

Check for solder bridges or poor solder connections on the circuit board foil and on the AUTO-NORM switch (SW5). Also check for wrong value parts on the circuit board.

The sweep circuits are operating properly.

TEST #6
TRIGGER CIRCUITS



Set the TIME/CM selector to the 200 mS position. Set the INT-EXT-LINE switch to INT. Set the AC-DC-TV switch to DC.

Measure the voltage at pin 8 of IC302 while you turn the VERT POS control fully clockwise and then fully counterclockwise. The voltage should read 0 to ≈ 4.5 volts DC.

The trigger circuits are working properly.

Set the TRIG LEVEL control on the front panel to its center of rotation. Then adjust the LEVEL SET control to obtain a 0 volts DC reading on the source (S) of Q301.

Q301 or Q302 incorrectly installed or faulty. Check associated circuitry (soldering, wrong value parts).

Repeat Test #6.

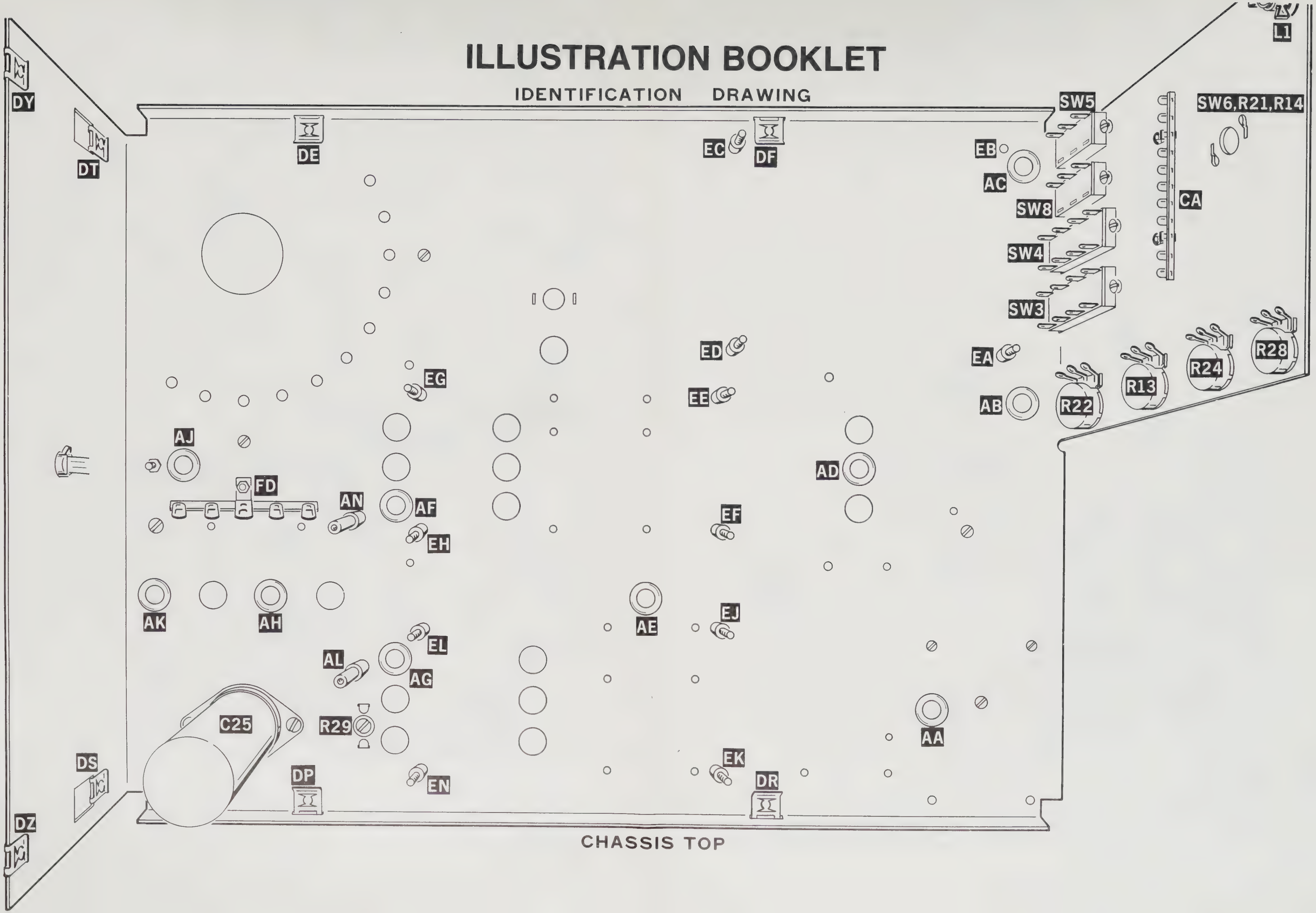
Measure the voltage at pin 1 of IC302. Then rotate the TRIG LEVEL control on the front panel from full counterclockwise to full clockwise. The voltage should change approximately 2 volts.

Q303, Q304, Q305, or Q306 incorrectly installed or faulty. Check associated circuitry (solder, wrong value parts).

Repeat Test #6.

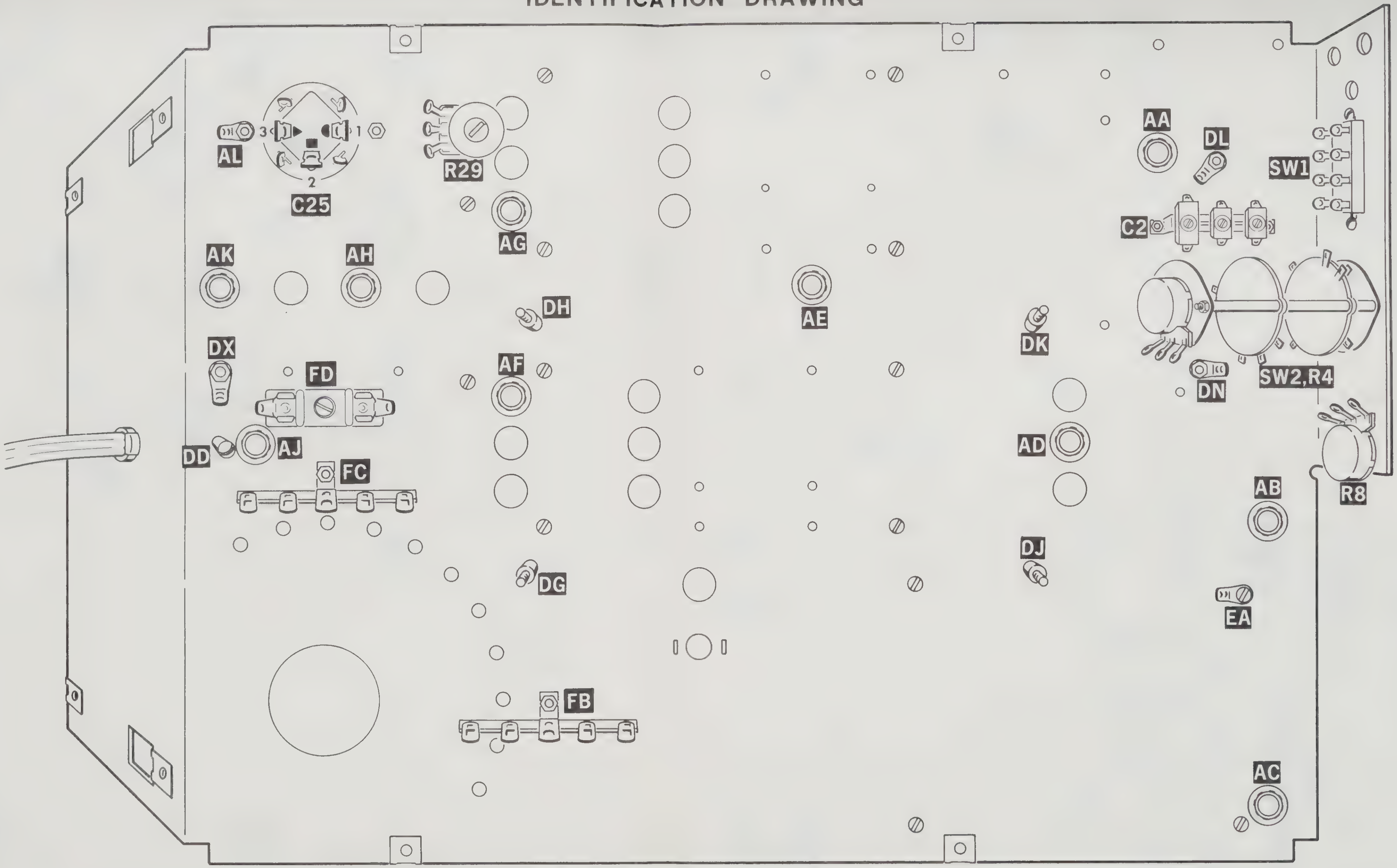
Replace IC302. Then repeat Test #6.

IDENTIFICATION DRAWING

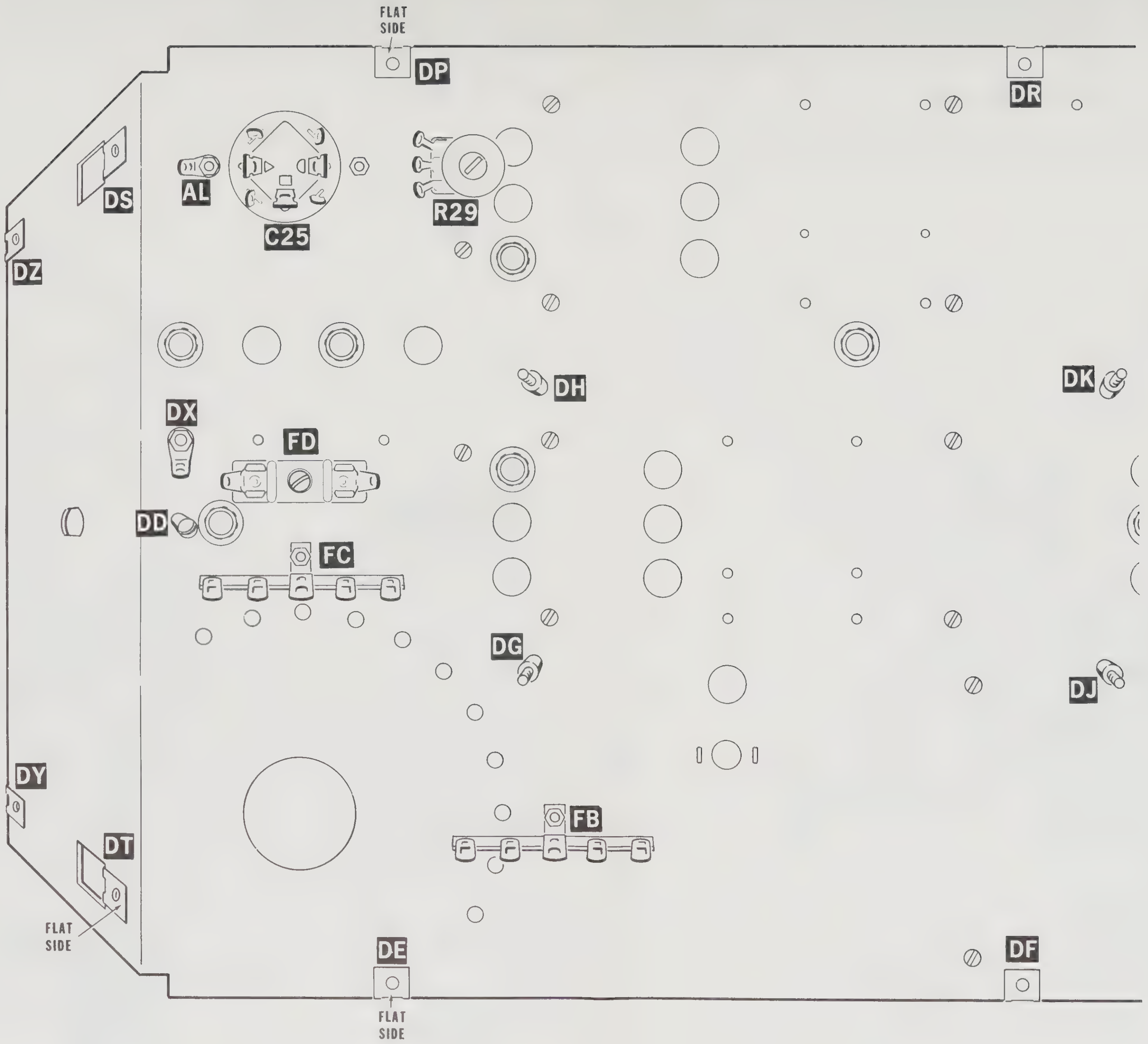


CHASSIS TOP

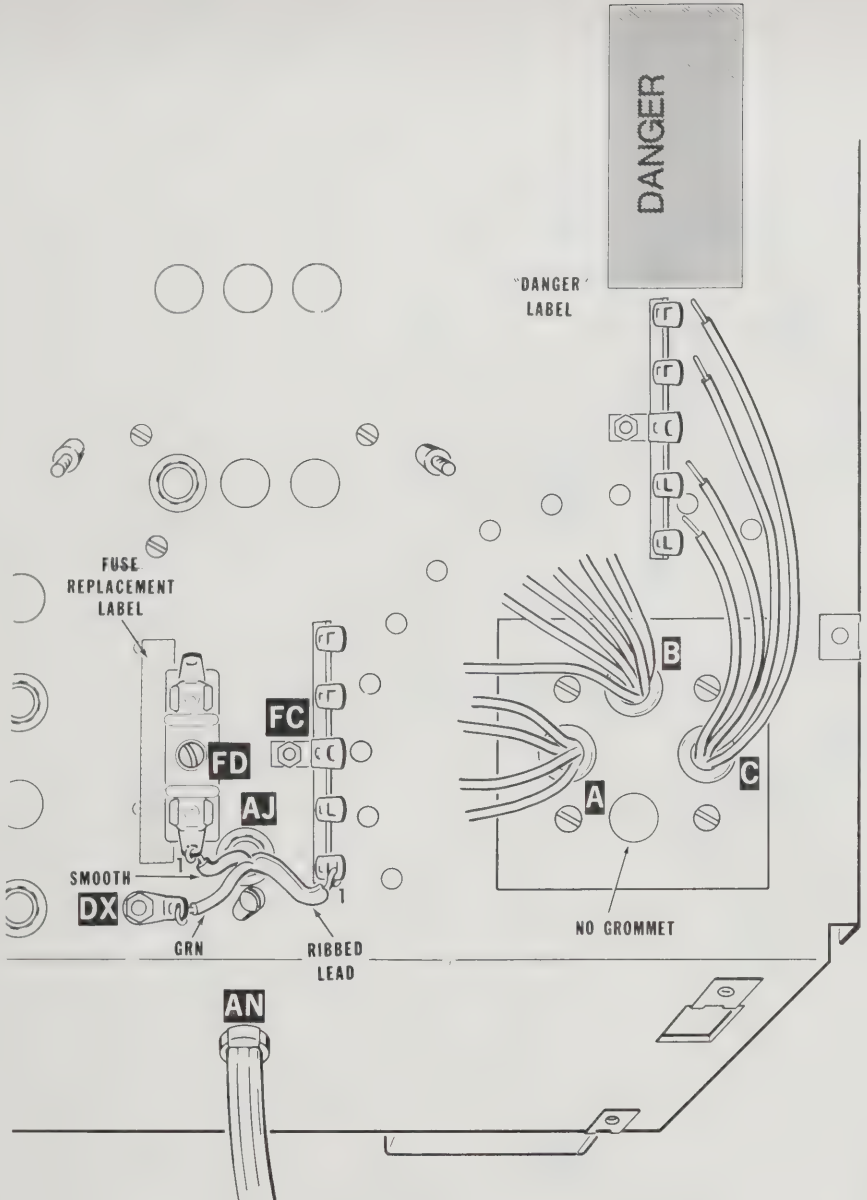
IDENTIFICATION DRAWING



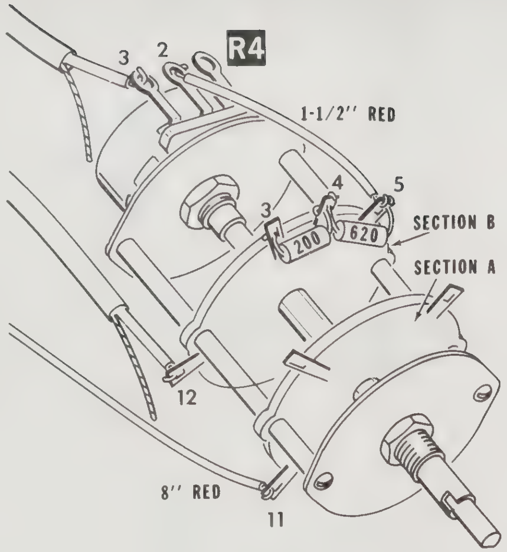
CHASSIS BOTTOM



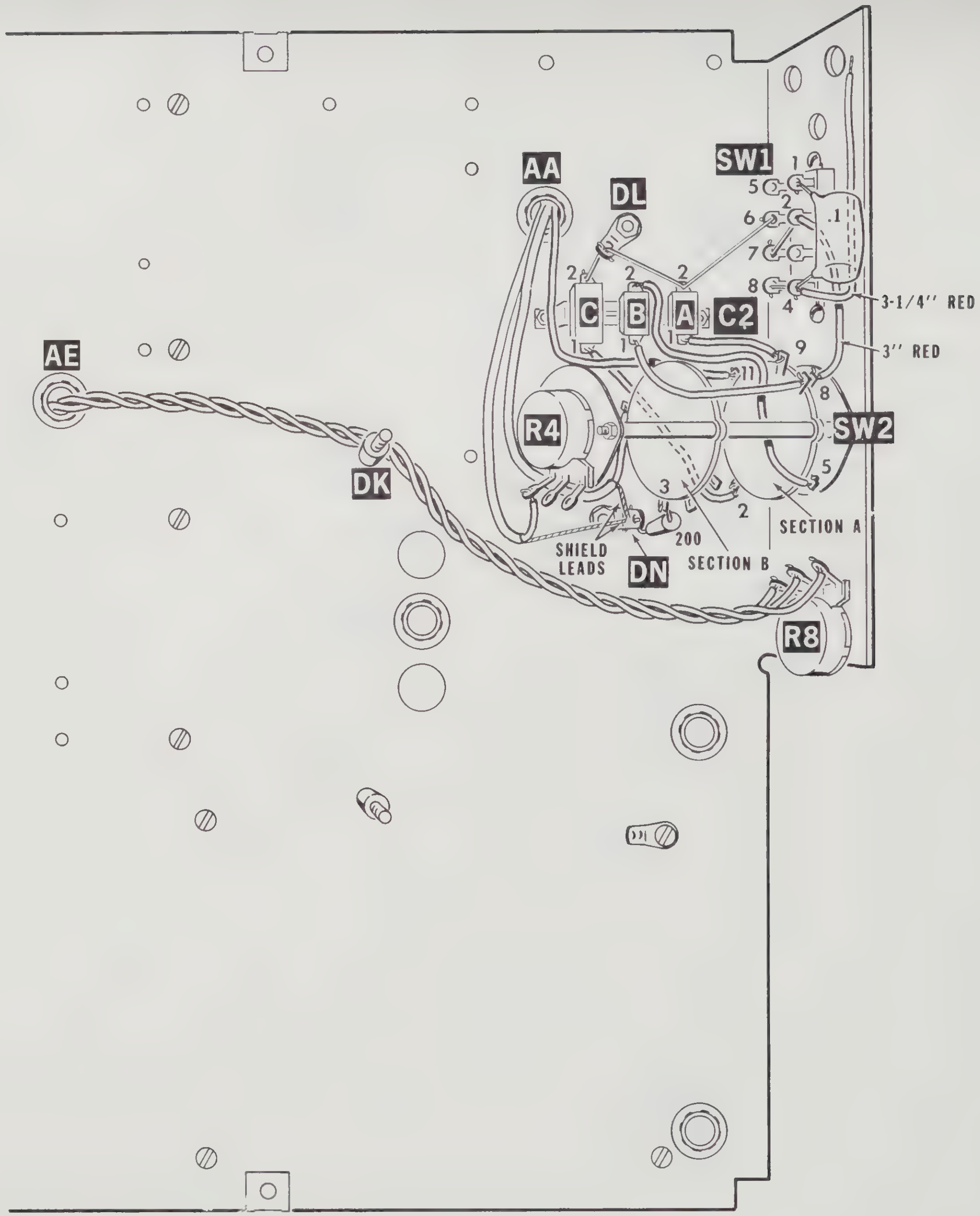
PICTORIAL 6-3



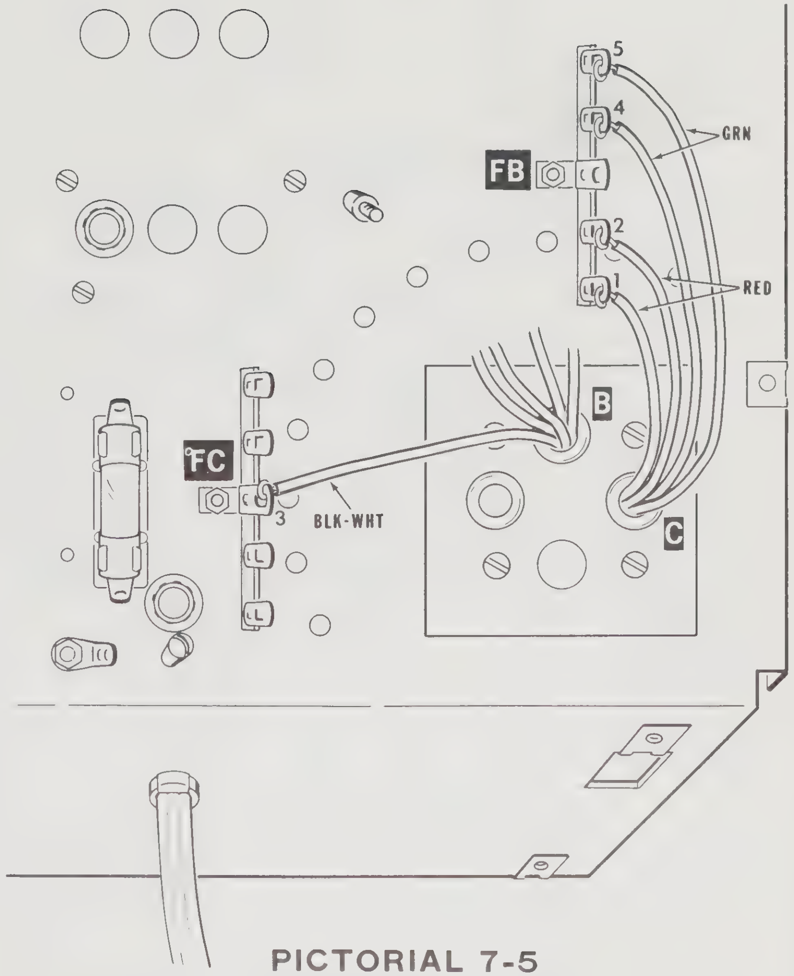
PICTORIAL 7-4



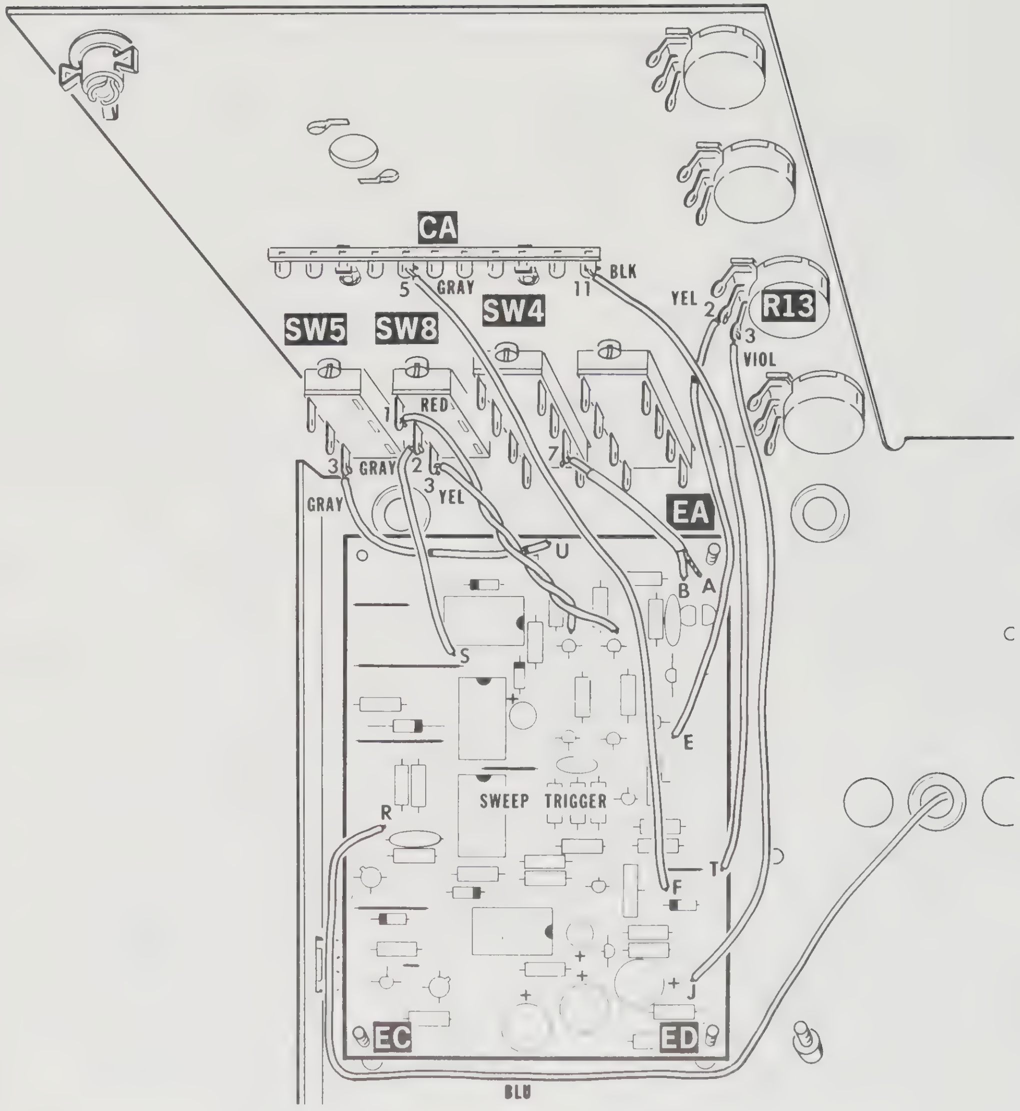
PICTORIAL 6-6



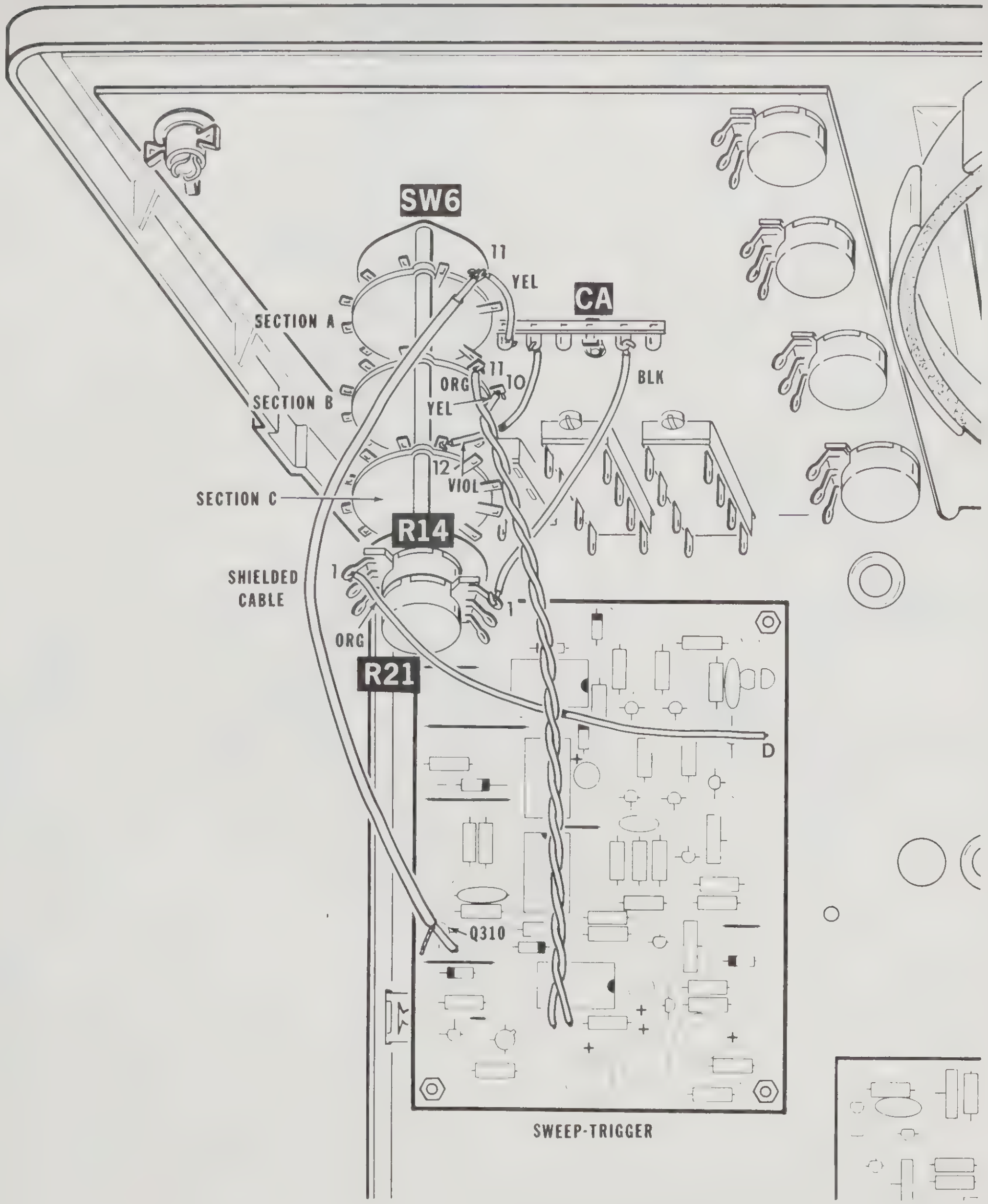
PICTORIAL 6-7



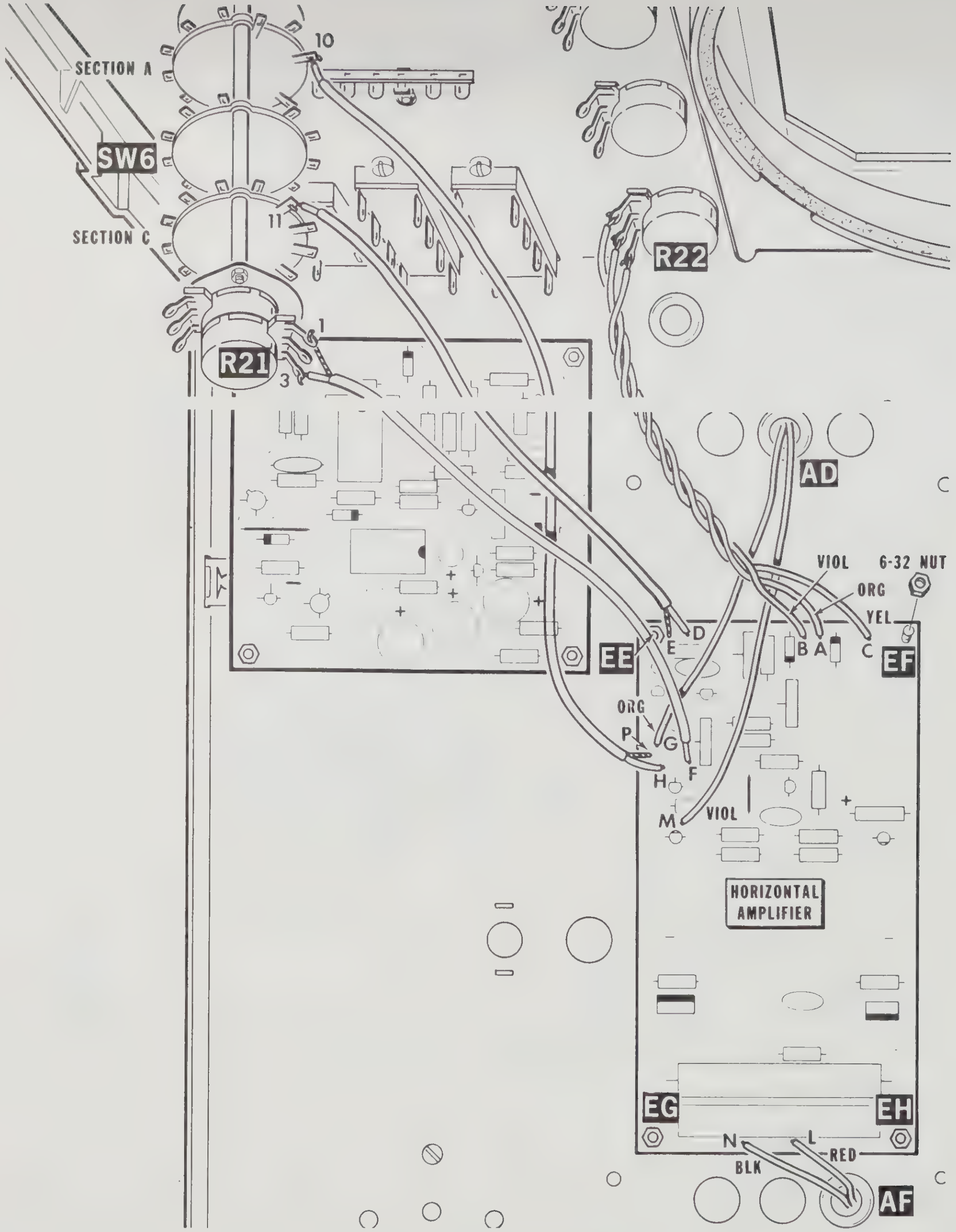
PICTORIAL 7-5



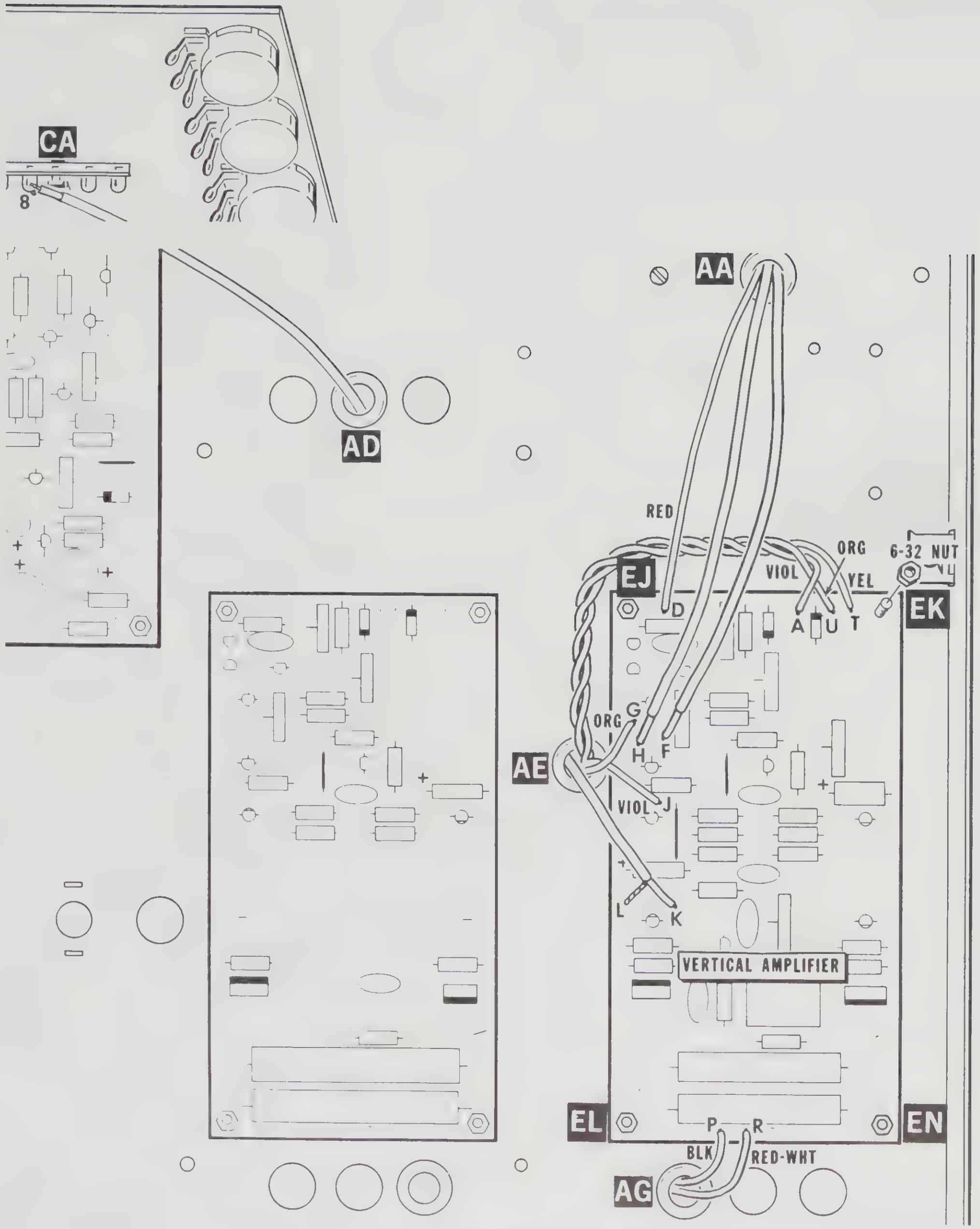
PICTORIAL 8-5



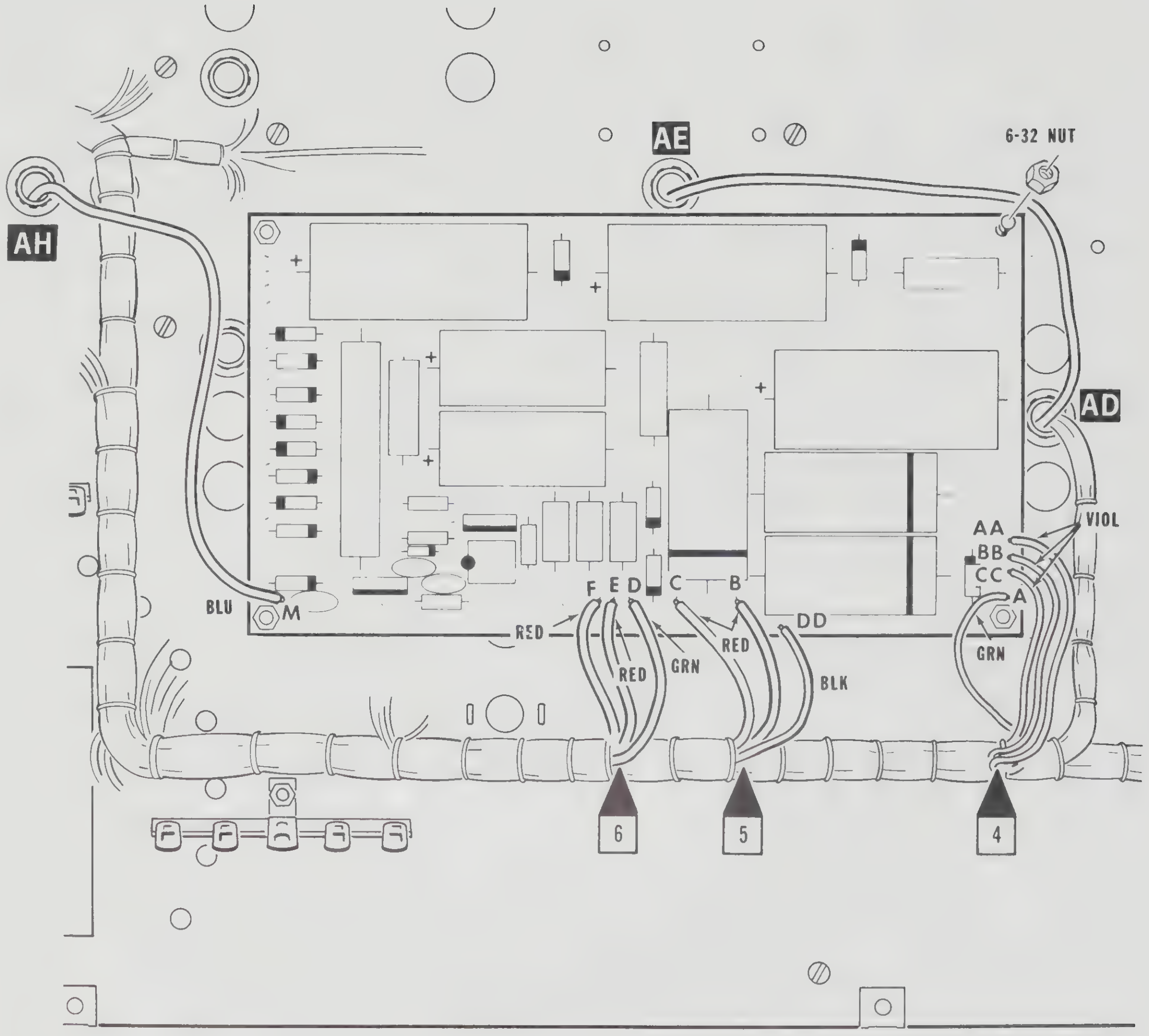
PICTORIAL 9-5



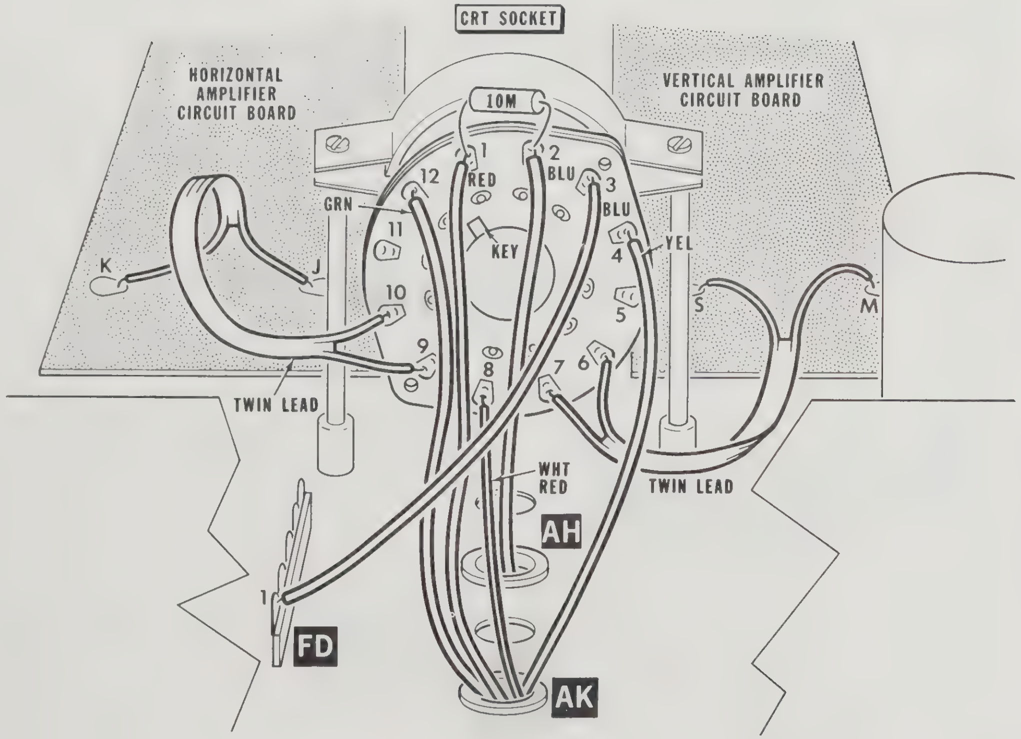
PICTORIAL 9-6



PICTORIAL 9-7



PICTORIAL 10-2



PICTORIAL 10-6

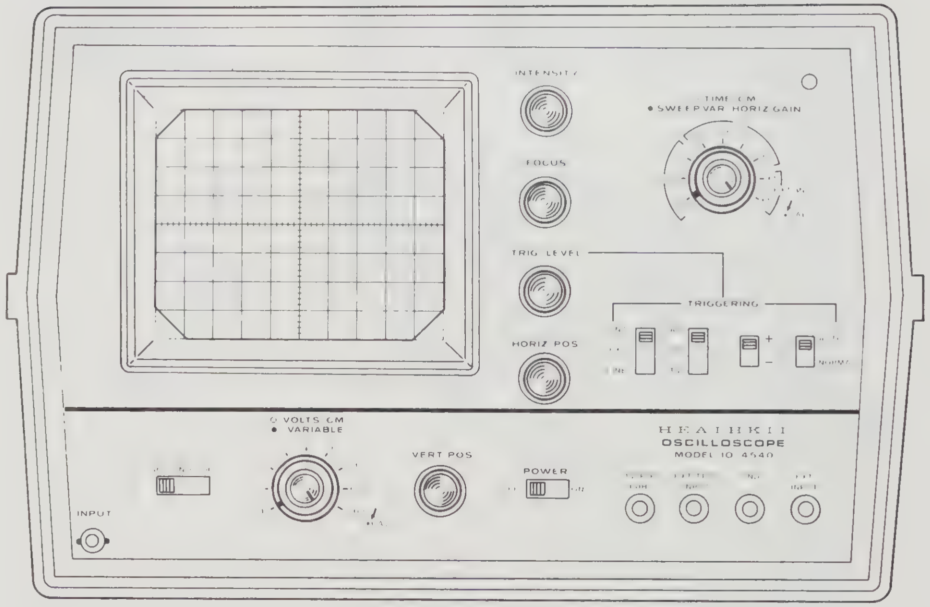
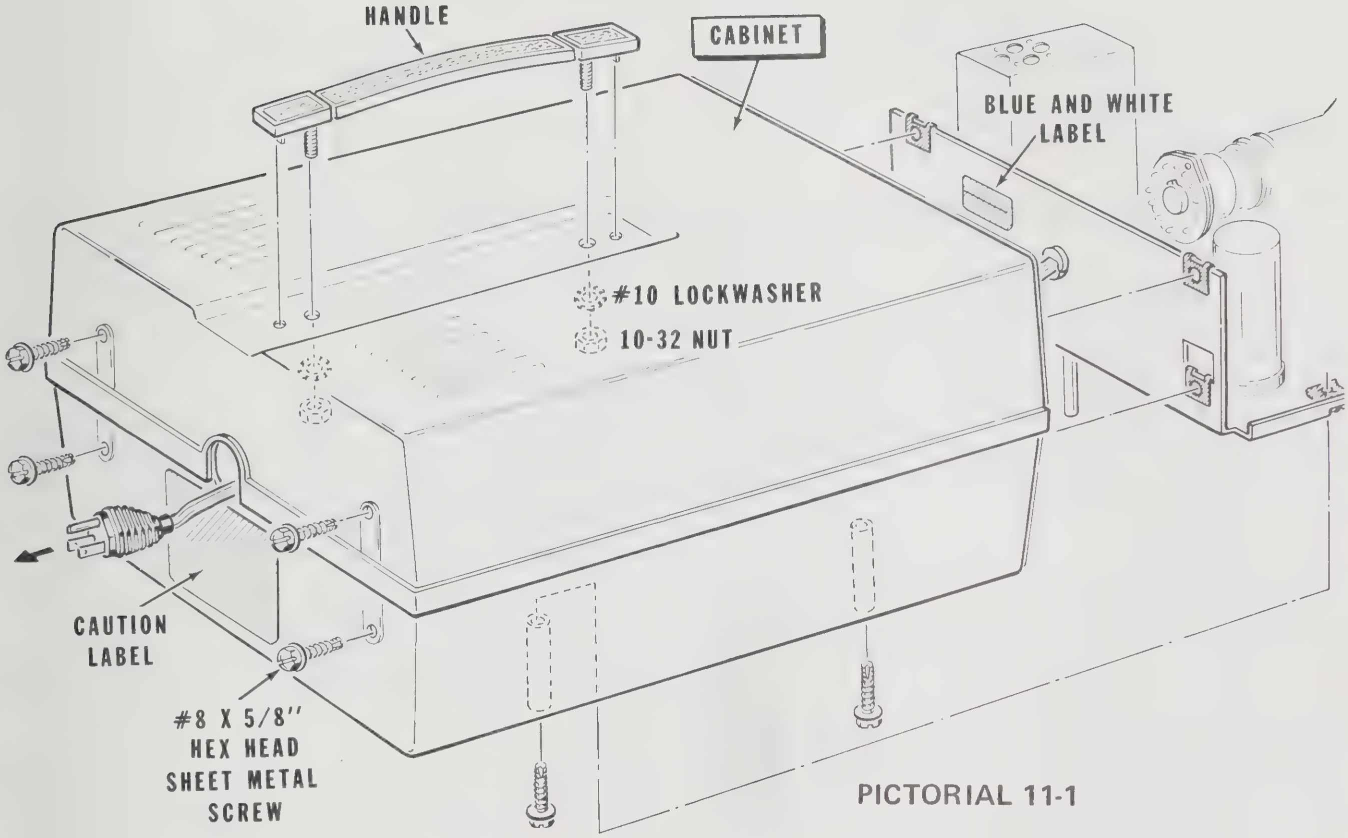


Figure 1-2

FINAL ASSEMBLY



PICTORIAL 11-1

Refer to Pictorial 11-1 for the following steps.

(✓) Locate the blue and white label. Be sure to refer to the numbers on this label in any communications you may have with the Heath Company about this kit.

(✓) Remove the protective paper backing from the blue and white label. Then affix the label to the rear chassis panel.

(✓) Locate the cabinet and handle. Mount the handle to the top of the cabinet with two #10 external lockwashers and two 10-32 nuts.

(✓) Route the line cord into the cabinet and out the hole in the back of the cabinet. Then slide the cabinet over the chassis.

(✓) Secure the cabinet to the chassis with eight #8 x 5/8" hex head sheet metal screws.

( ) Locate the "Caution" label and remove the protective paper backing. Then affix the label to the back of the cabinet in the space provided.

This completes the assembly of your Oscilloscope. Proceed to "Operation."

OPERATION

The Calibration section of the Manual introduced you to the operation of your Oscilloscope. This section will help you obtain the greatest use from your instrument by showing you various uses and applications for it.

NOTE: Your Oscilloscope has a highly sensitive DC amplifier. It is therefore normal for the trace to drift vertically somewhat during the first half hour or so after it is turned on. Occasionally, the DC BALANCE control (located on the vertical amplifier circuit board) should be readjusted. Perform this adjustment carefully, in the following manner:

1. Set the AC-GND-DC switch to GND.
2. Turn the VOLTS/CM switch to the .02 position.
3. Turn the VARIABLE control (on the VOLTS/CM selector) alternately clockwise and counterclockwise and note the shift in the trace location.
4. Adjust the DC BAL control (located on the vertical amplifier circuit board) until there is no trace movement between the clockwise and counterclockwise positions of the VARIABLE control.

Refer to Figure 1-2 in the Illustration Booklet for a description of the front panel control functions.

WAVEFORM DISPLAY THEORY

Lines or waveforms appear on the face of a cathode ray tube (CRT) when its electron beam is deflected by varying charges on its deflection plates. Generally, an internal sweep generator in the oscilloscope varies the charge on the horizontal deflection plates and moves the beam rapidly from left to right. You can also produce a horizontal sweep by applying an external sweep signal to the HORIZ IN jack of the Oscilloscope.

Vertical deflection results from a signal applied to the VERT IN jack of the Oscilloscope. The signal is amplified and applied to the vertical deflection plates in the CRT.

When the period of the vertical input signal is equal to the horizontal sweep time, one complete cycle will be displayed on the CRT face. If the signal frequency is higher, more than one cycle will be displayed. The height of the waveform on the screen will be proportional to the amplitude of the vertical input signal, and can be controlled by the setting of the VARIABLE control and the VOLTS/CM selector.

With this very brief theory of operation, you can see that an oscilloscope will display the waveform of the signal voltage that is fed to its vertical input. The signal voltage may be taken from an audio amplifier, a television receiver, a transmitter, or almost any electronic circuit. Some of the more common oscilloscope applications are described in the following pages.

OPERATIONAL EXAMPLE

The following example will help you become more familiar with the control functions, especially the sweep and trigger controls.

Connect a sine wave source to the vertical INPUT connector. Set the TRIGGER switches to INT, AC, (+), and NORM.

Turn the TRIGGER LEVEL control to the center of rotation. Adjust the VOLTS/CM selector to obtain a trace 3 or 4 centimeters high. Adjust the HORIZONTAL POSITION control so the left edge of the trace is just inside the left margin of the graticule. Set the TIME/CM selector to display a few cycles of the waveform. Adjust the VERTICAL POSITIONING control to center the trace vertically.

Now carefully readjust the TRIGGER LEVEL control and observe how the left edge (starting point) of the sweep moves upward as the control is turned clockwise, and downward as the control is turned counterclockwise. See A on Figure 2-1.

Switch the TRIGGER +/– switch to the "–" position, and note that the TRIGGER LEVEL control has the same effect except that the sweep start point is on the negative slope of the waveform.

There is no fixed rule for setting the TRIGGER LEVEL control, as no two waveforms are alike. For example, assume that you want to examine the "spike" on waveform B of Figure 2-1. By adjusting the TRIGGER LEVEL control so the sweep starts just before the spike, as in C in Figure 2-1, and decreasing the time required for one complete sweep by changing the position of the TIME/CM selector, the spike can be spread out across a large area of the screen for closer observation, as in D of Figure 2-1.

By reading the TIME/CM selector, you can determine the duration of the spike. This feature is also useful to observe distortion in circuits using square wave signals.

The TIME/CM selector should be set to display the desired waveform or portion of a waveform. Occasionally it may also be necessary to use the VARIABLE. However, the sweep time is not calibrated when the VARIABLE is used. Refer to the formula on Page 127, or the "TIME/CM FREQUENCY Correlation Chart" on Page 128 to determine unknown frequencies or sweep times when you use the calibrated positions of the TIME/CM selector.

The TRIGGER INT/EXT switch permits you to choose between internal or external triggering signals. The INT (internal) trigger is derived from the vertical input signal. The EXT (external) trigger position allows the sweep to be triggered from external sources, such as TV horizontal or vertical sync pulses, that are not necessarily related to the vertical input signal.

When the TRIGGER AUTO/NORM switch is in the AUTO position, a sweep appears on the screen even in the absence of a signal. The AUTO position is useful for simple waveforms with frequencies from about 40 cycles and upward. This switch position is also useful for signals that are too weak to trigger the sweep circuits in the normal position.

The TRIGGER AC/DC switch will normally be in the AC position except when you use very low frequency or DC signals as a trigger source.

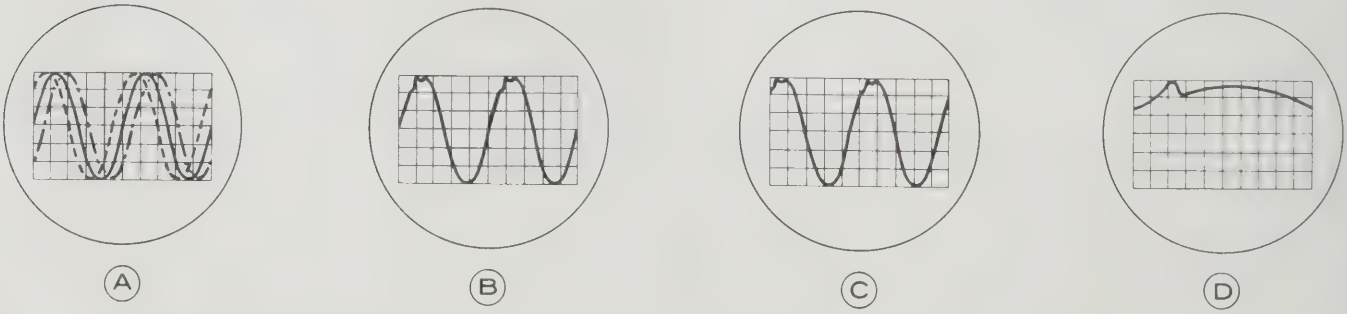


Figure 2-1

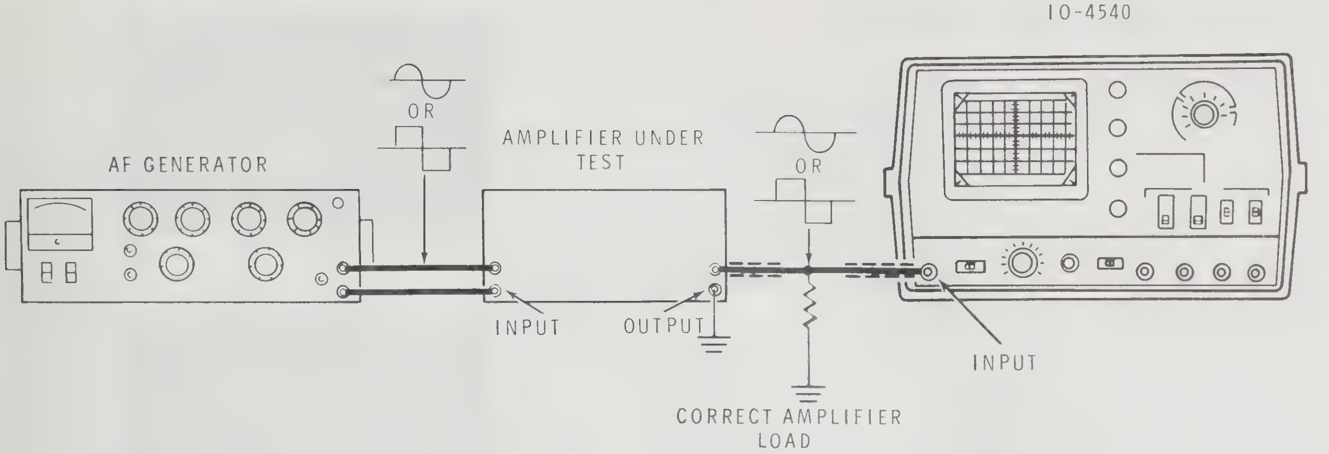


Figure 2-2

AUDIO AMPLIFIER CIRCUITS

You can observe frequency response, distortion, and gain in an audio amplifier by observing its output waveform when a sine wave or a square wave is applied to the amplifier input.

Figure 2-2 shows a typical setup for checking an audio amplifier. The audio generator injects either a low distortion sine wave or square wave signal into the input of the amplifier. The amplifier's output terminates in the proper load for the amplifier, and the oscilloscope is connected across the load.

The waveform produced by the audio generator will not be changed as it passes through properly operating circuits of a high-fidelity amplifier. However, if any circuit is not operating properly, the output waveform will be distorted.

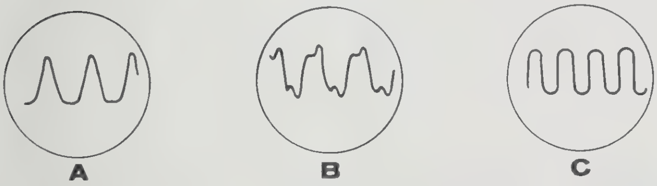


Figure 2-3

Figure 2-3, Part A, shows a sine wave with a serious flattening of one peak. This represents about 10% harmonic distortion, which could be caused by an improperly biased stage or a defective tube or transistor, and is a particularly objectionable amplifier fault. Figure 2-3, Part C, shows a flattening of both peaks, which usually indicates an overdriven stage somewhere in the amplifier.

While a sine wave signal will tell a lot about an amplifier, a square wave gives an additional indication of amplifier performance with respect to frequency response, amplitude distortion, and phase shift. The square wave generator must produce a clean waveform with straight sides, sharp corners, and flat horizontal lines, as shown in Figure 2-4, Part A.

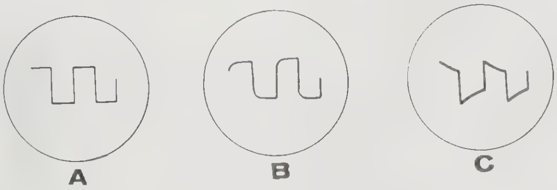


Figure 2-4

When a low frequency square wave signal is fed into the input of an amplifier, its output waveform will be a faithfully reproduced square wave if its frequency response is good and if little amplitude or phase distortion occurs in its circuits. The shape of the leading edge of an output waveform, as shown in Figure 2-4, Part B, indicates poor high frequency response. This may be caused by amplitude distortion (clipping), or phase shift, or both.

The slope of the flat portion of the waveform, as shown in Figure 2-4, Part C, indicates poor low frequency response.

TELEVISION RECEIVER CIRCUITS

An oscilloscope can also be used to service television receivers. There are two methods of using the oscilloscope in TV service work. One is the point-to-point probing to study components of a transmitted television signal and their effect on receiver circuits. The other method uses the signal from a sweep generator and is used primarily for the alignment of a receiver. These two methods will be treated separately in the following paragraphs.

Point-to-Point Signal Tracing

Most television manufacturers supply service information that shows correct oscilloscope patterns at various points in the receiver. These patterns are generally of the composite video signal or synchronizing signals that are received from a television transmitter, or generated within the receiver. Some of these patterns are shown in Figure 2-5, with the signal frequency indicated for each pattern. No special equipment is required for observing these patterns on your Oscilloscope, except a demodulator probe to detect modulation envelopes in the IF or RF amplifier sections.

Figure 2-6 is a simplified block diagram of a typical television receiver. It shows various stages and points for connecting the Oscilloscope probe. The letters at each test point indicate the type of probe to use, and the setting of the Oscilloscope's sweep speed. These letters are defined in the following chart.

PROBE	SWEEP SPEED	
R Direct	H	20 μs/cm
D Demodulator	V	2 ms/cm (use TV trigger)
	A	Audio test frequency

NOTE: For simplicity, all amplifier stages are shown within one block of the diagram in Figure 2-6. Tests may be made at the input or output of individual amplifier stages using the indicated probe and sweep frequency.

At any point up to the video detector, the voltages will be quite small and considerable vertical gain will be required. Within the sync circuits and deflection circuits, however, these voltages are larger and very little amplification is required.

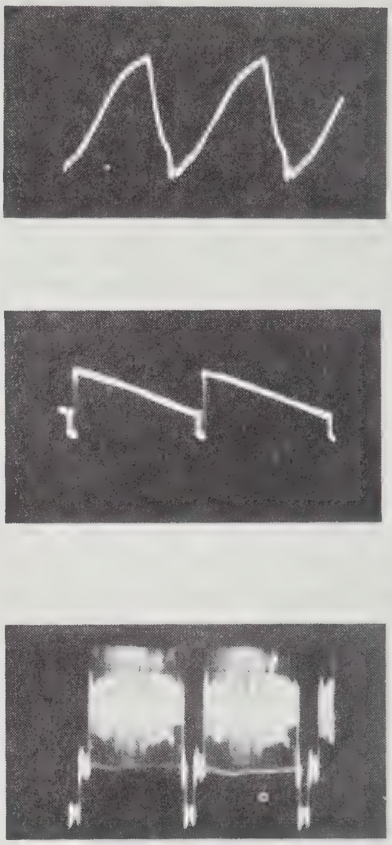


Figure 2-5

In checking the waveforms, remember that two basic frequencies are involved in the television signal. The vertical or field frequency is 60 Hz. Any investigation of the circuit except within the horizontal oscillator, its differentiator network, and the horizontal amplifier stages, can generally be made using a sweep speed of 5 ms/cm. In order to study the horizontal pulse shape or the operation of the horizontal deflection system, it is generally necessary to operate the sweep generator at 20 μs/cm. This sweep rate will show the waveform of about three lines of the signal.

The point-to-point signal tracing method of analysis is most helpful in going through a receiver, since faulty receiver operation is generally caused by the loss of all or a significant portion of the picture information and pulses at some stage within the receiver. With a basic understanding of the function of each part of the signal and with a knowledge of what the signal actually looks like at any part of the receiver, it is a comparatively simple matter to isolate the defective portion and the particular component causing the failure.

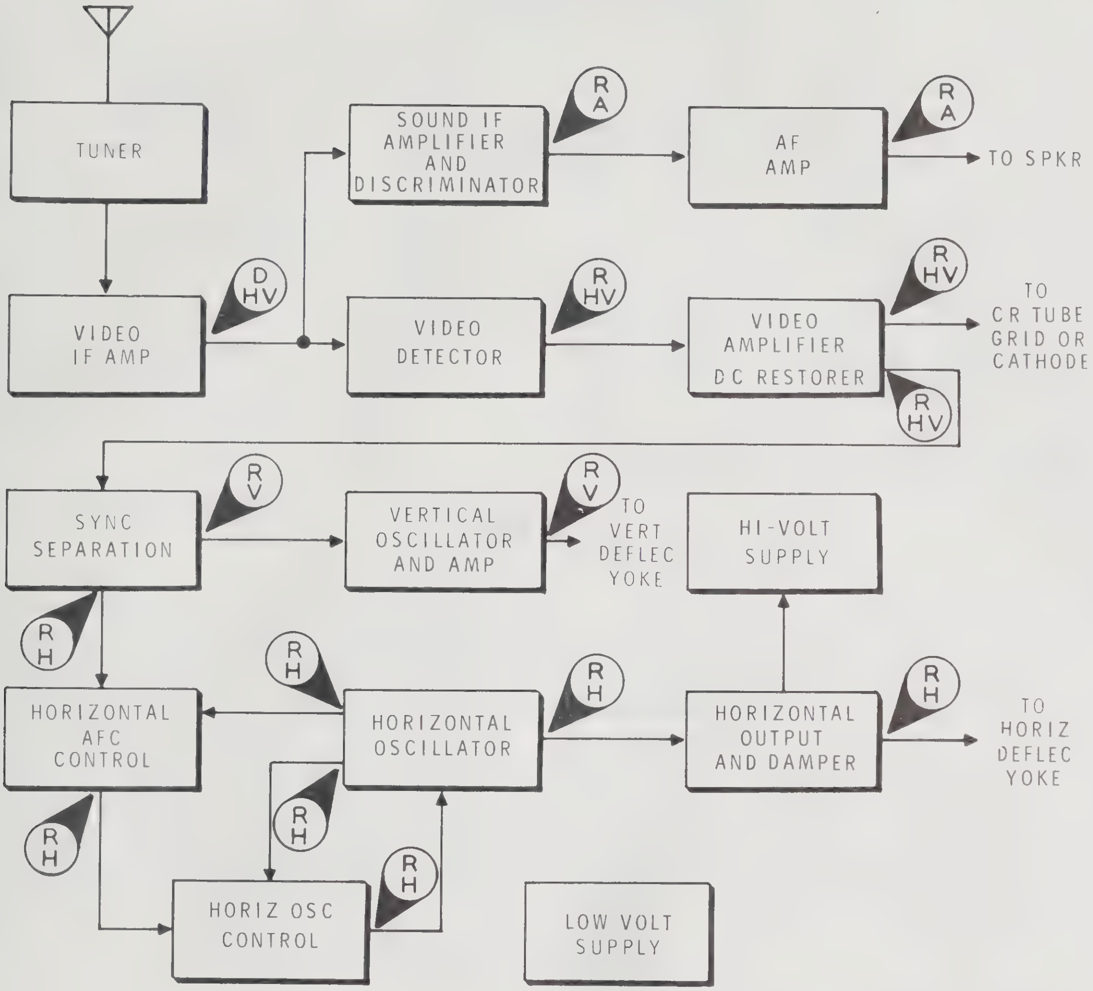


Figure 2-6

Bear in mind that a phase shift of 180 degrees takes place in some circuits of a receiver. Therefore, the pattern displayed on the Oscilloscope screen may be inverted in some cases. The pattern or form of the wave should not be changed however.

Video amplifier response can be measured in exactly the same manner described for testing an audio amplifier, and again a square wave signal is the most efficient method to use. Because a video amplifier must pass signals as low as 20 Hz and as high as 4 or 5 MHz, a more comprehensive test is required. Usually a 60 Hz check is made to cover low and medium frequency characteristics. A second check at 25 kHz covers the high frequency portion of the response curve. Again, such tests require accuracy on the part of the Oscilloscope. The signal tracing technique can be used in these tests also. The square wave generator is fed directly into the first video amplifier stage. Very low signal input will be required. Then the Oscilloscope is connected to various stages, starting near the output end and working back until any distortion is isolated. Patterns such as Figure 2-4, Part B, (on Page 123) are responsible for poor picture detail or fuzziness, while the distortion of the waveform shown in Figure 2-4, Part C, can cause shading of the picture from top to bottom.

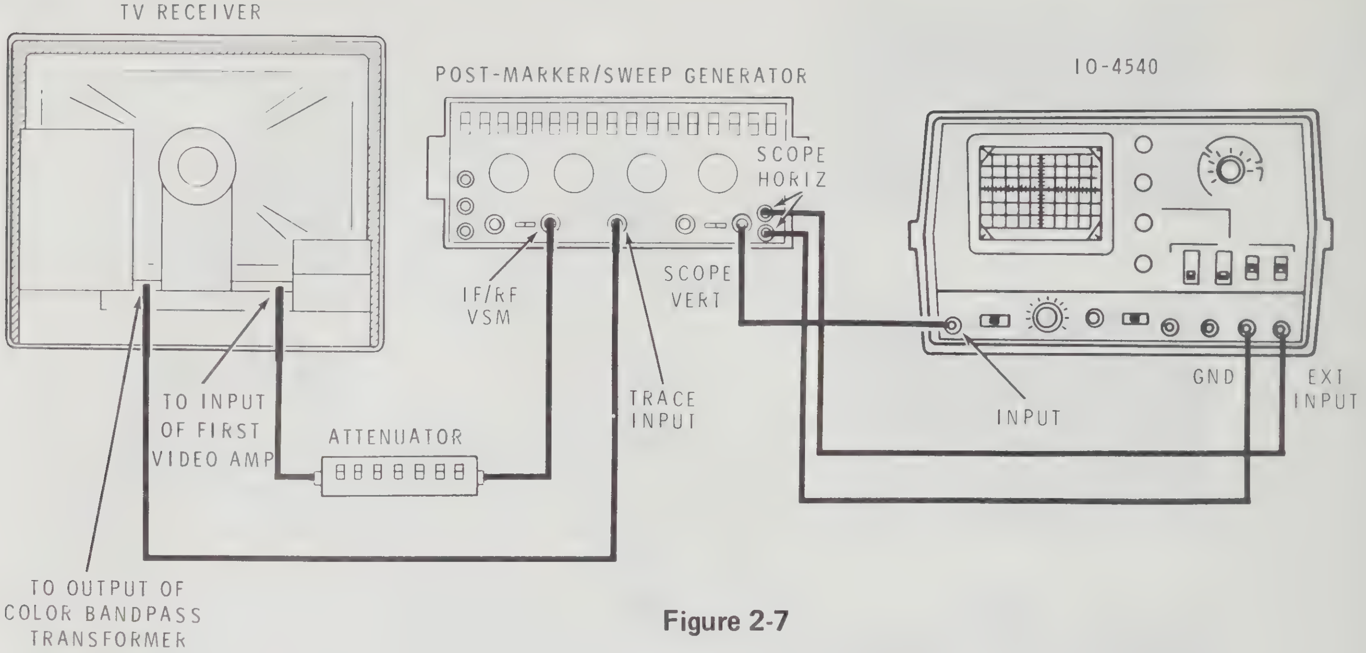

TV RECEIVER
POST-MARKER/SWEEP GENERATOR
IO-4540
SCOPE HORIZ
SCOPE VERT
IF/RF VSM
TRACE INPUT
TO INPUT OF FIRST VIDEO AMP
ATTENUATOR
INPUT
GND
EXT INPUT
TO OUTPUT OF COLOR BANDPASS TRANSFORMER

Figure 2-7

Receiver Alignment

Alignment of television RF and IF circuits requires the use of an alignment sweep generator as well as the Oscilloscope. This sweep generator supplies an RF signal that sweeps across all the frequencies of a television channel or IF amplifier 60 times a second. The sweep generator also supplies 60 Hz sweep voltage to the Horizontal input of the Oscilloscope. Figure 2-7 shows a typical setup for the alignment of a television receiver.

The exact procedure for alignment differs with various receivers and with different sweep generators. Manufacturer's service data usually includes alignment procedures and correct response waveforms.

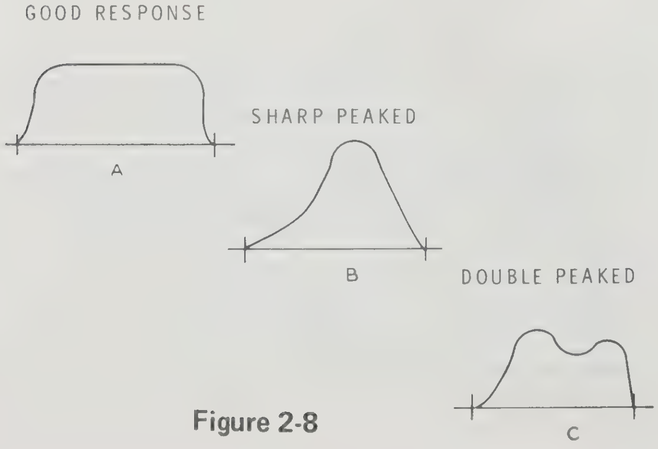


Figure 2-8

Figure 2-8, Part A, shows a typical response curve for a properly aligned receiver. Notice that the top part of the waveform is essentially flat, and tapers sharply at both ends. The waveform shown in Part B of Figure 2-8 might result if the IF stages of the receiver were aligned too sharply or all at the same frequency. This would produce a narrow bandwidth and seriously affect picture quality. A misalignment of one or more IF stages would produce a waveform like that shown in Figure 2-8, Part C, which would also reduce picture quality.

AC VOLTAGE MEASUREMENTS

Because of its characteristics, the oscilloscope is particularly suited to the measurement of AC voltages. In some television circuits it is imperative that such measurements be made accurately with respect to wave shape, so that the conventional rms-indicating AC voltmeter is no longer adequate. Most television service bulletins specify peak-to-peak voltages which appear at various points of the circuit.

The Oscilloscope can be used to display and accurately measure these voltages. It can be easily calibrated for this purpose by using a known accurate external AC voltage source or, in the case of this Oscilloscope, the built-in 1 volt peak-to-peak reference source.

This Oscilloscope will normally measure 120 volts, but can be calibrated for measuring higher voltages by "uncalibrating" to a lower 1 volt reference mark on the graticule with the VARIABLE control.

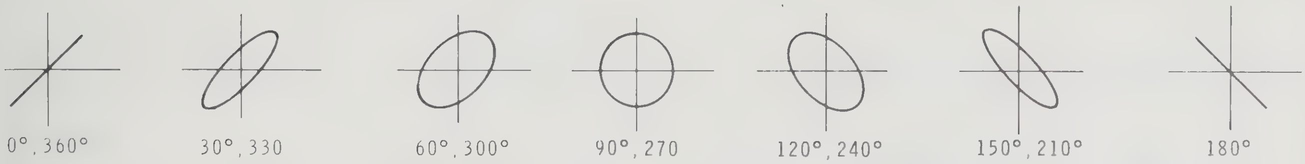


Figure 2-10

The following relationships exist for sine wave AC voltages:

rms x 1.414 = Peak Voltage
rms x 2.828 = Peak-to-Peak Voltage
Peak Voltage x .707 = rms Voltage
Peak-to-Peak Voltage x 0.3535 = rms Voltage

FREQUENCY MEASUREMENTS

Frequency measurements can be made with an accuracy limited only by the reference source available. At times, this can be the 60 Hz line frequency which is usually controlled very closely. The unknown frequency is applied to the vertical input and the reference frequency to the horizontal input. The internal sweep generator is not used. The resultant pattern may take on any one of a number of shapes. Typical patterns are shown in Figure 2-9. These patterns are called Lissajous figures. They are obtained when sinusoidal AC voltages are applied simultaneously to the two sets of oscilloscope plates. The resultant pattern depends upon the relative amplitudes, frequencies, and phase of the two voltages. The frequency ratio can be figured from the formula:

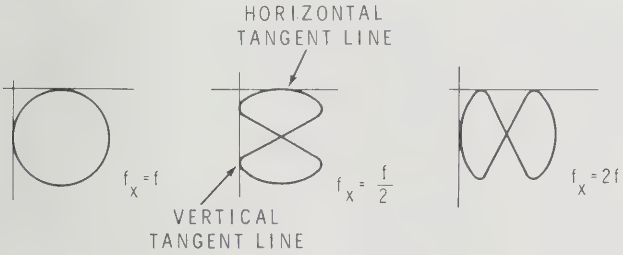


Figure 2-9

$$f_x = \frac{Th \times f}{Tv}$$

where f_x is the unknown frequency. Th is the number of loops which touch the horizontal tangent line; Tv is the number of loops which touch the vertical tangent line; f is the known frequency.

When using Lissajous figures, it is good practice to have the figure rotating slowly rather than stationary. This eliminates the possibility of an error in counting the tangent points. If the pattern is stationary, a double image may be formed. In such cases, the end of the trace should be counted as one-half a tangent point rather than a full point. This condition may occur when neither frequency can be varied.

PHASE MEASUREMENTS

It is sometimes necessary to determine the phase relationship between two AC voltages of the same frequency. You can accomplish this quite easily by applying one of the voltages to the horizontal input and the other voltage to the vertical input. The phase relationship can be estimated from Figure 2-10.

NOTE: For proper displays, the horizontal amplifier gain must be set to equal the vertical gain.

To calculate the phase relationship, use the following formula:

$$\sin \theta = \frac{A}{B}$$

As shown in Figure 2-11, the distance A is measured from the X axis to the intercept point of the trace and the Y axis. The distance to B represents the height of the pattern above the X axis. The axis of the ellipse must pass through the point 0.

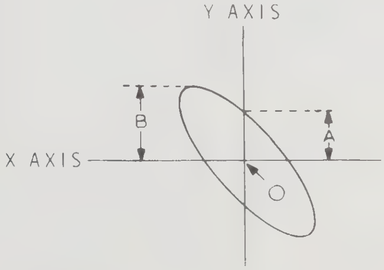


Figure 2-11

TIME/CM-TO-FREQUENCY CORRELATION

You can determine the frequency of a constant signal with your Oscilloscope by using the following formula.

NOTE: The long vertical and horizontal lines on the graticule are spaced 1 cm (centimeter) apart. The short lines on the center vertical and horizontal lines are 2 mm (millimeters) apart. The usable graticule area is 8 cm high and 10 cm wide.

$$\text{Frequency} = \frac{1}{\text{TIME/CM selector setting multiplied by the number of centimeters on the CRT covered by one cycle of the unknown frequency.}}$$

For example: Let's say that one cycle of the unknown frequency covers five centimeters on the CRT (with the VARIABLE control full clockwise). The TIME/CM selector is set at 2 μS (2×10^{-6}). Using the formula above:

$$\text{Frequency} = \frac{1}{\frac{2 \times 10^{-6}\text{ sec}}{\text{Cm}} \times 5\text{ Cm}}$$

Frequency = 100 kHz.

NOTE: The VARIABLE control cannot be used when you are computing with this equation, since there are no calibrated values associated with it. This control must be kept in the CAL (full clockwise) position when you are determining an unknown frequency.

TIME/CM-FREQUENCY CORRELATION CHART

TIME/CM SELECTOR	TIME FOR 1 CM SWEEP	FREQUENCY (Hz) FOR 1 CYCLE/10-CM (full screen width)	FREQUENCY (Hz) FOR 5 CYCLES/10 CM (full screen width)
.2 μS 2 μS	.2 μ sec 2 μ sec	500,000 50,000	2500,000 250,000
20 μS	20 μ sec	5,000	25,000
200 μS	200 μ sec	500	2500
2 mS	2 m sec	50	250
20 mS	20 m sec	5	25
200 mS	200 m sec	.5	2.5

NOTE: When the trigger selector is in the "line" position, a trace may not be visible on the CRT at sweep speeds above 20 μsec. The Oscilloscope will still be triggered, but the writing speed will be too fast to light the CRT.

IN CASE OF DIFFICULTY

This section of the Manual is divided into four parts. The first part, "General Troubleshooting Information," outlines possible causes that are the most often sources of trouble in newly assembled kits. Go through this part very carefully and apply these checks to your kit.

The second part "Troubleshooting Precautions and Notes," outlines precautions you should take when troubleshooting your Oscilloscope. Read this part carefully so you do not damage your oscilloscope while searching for the difficulty.

The third part, the "Troubleshooting Charts," is really two parts. The first part of this section consists of various tests to localize the trouble. You will then be directed to the second part, where you will pinpoint the trouble within the local area or circuit board.

The fourth part, "Checking Components," shows you how to use an ohmmeter to determine if a suspected component is faulty.

Voltages are provided on the "Circuit Board Voltage Charts," on Pages 147-149, and on the Schematic.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

GENERAL TROUBLESHOOTING INFORMATION

The following paragraphs deal with the types of difficulties that may show up right after a kit is assembled. These difficulties are most likely to be caused by assembly errors or poor soldering.

1. Recheck the wiring. Trace each wire lead in colored pencil on the Pictorial where it is installed, as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you consistently overlooked.

2. About 90% of the kits that are returned for repair do not work properly due to poor solder connections. Therefore, you can eliminate many troubles by reheating all connections to make sure that they are soldered as described in the "Soldering Instructions," at the front of this Manual.

3. Check to make sure that all transistors are in their proper locations. Make sure that each transistor lead is connected to the proper point and that the transistor flats are properly positioned.

4. Check the values of the parts. Be sure that the proper part has been wired into the circuit as shown in the Pictorials and called out in the wiring instructions. For example, it would be easy to install a 200 Ω (red-black-brown) resistor for a 1000 Ω (brown-black-red) resistor.

5. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring. Check for solder bridges between circuit board foils. Compare your foil pattern against the "Circuit Board X-Ray Views" on Page 143-145.

SHIPPING PRECAUTIONS

If you ship your Oscilloscope to the Heath Company or to a Heathkit Electronic Center for repair or calibration, first remove the CRT. If you want to ship the CRT, ship it separately from the Oscilloscope. You may wish to save the CRT carton in the event that you may some day wish to ship the CRT.

TROUBLESHOOTING PRECAUTION AND NOTES

WARNING: The full AC line voltage and high DC voltage is present at several places in the Oscilloscope. (See Pages 150 and 151.) Be careful to avoid electrical shock when you work on the Oscilloscope.

1. Be cautious when you test transistors and integrated circuits. Although they have almost unlimited life when used properly, they are easily damaged by excessive voltage and current.
2. Be careful so you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short out a bias or voltage supply point, it may damage one or more components.
3. DO NOT remove any components while the Oscilloscope is turned on.
4. When you make repairs to the Oscilloscope, make sure you eliminate the cause as well as the effect of the trouble. If, for example, you should find a damaged resistor, be sure you find out what caused the resistor to become damaged. If the cause is not eliminated, the replacement resistor may also become damaged when the Oscilloscope is turned on again.
5. Refer to the "X-Ray Views," and the "Schematic Diagram," to locate various components.
6. When the oscilloscope Trigger Selector is in the "LINE" position, a trace may not be visible on the CRT above 20 μsec. The Oscilloscope will still be triggered, but the writing speed will be too fast to light the CRT.

TROUBLESHOOTING CHARTS

The "Troubleshooting Charts" are designed to pinpoint a trouble through a series of tests. The following symbols and procedures are used in the charts.

YES	Follow the "YES" arrow when you obtain the correct measurement or condition.
NO	Follow the "NO" arrow when you do not obtain the correct measurement or condition.
≈	This symbol in a step means that the voltage listed immediately after the symbol may vary as much as ±20%. For example: If the step says, "≈ 100 volts DC," it means that the voltage could be 80 to 120 volts DC.

Components are listed in the order in which failure or a problem is most likely to occur.

All voltage measurements were made with a high impedance voltmeter with a nominal line voltage of 120 volts AC.

Set the front panel controls as follows:

INTENSITY: Center of rotation.

FOCUS: Center of rotation.

TRIGGER LEVEL: Center of rotation.

HORIZ POS: Center of rotation.

TIME/CM: X10 (full clockwise).

SWEEP VAR/HORIZ GAIN: CAL (full clockwise.

INT-EXT-LINE: INT

AC-DC-TV: AC

POSITIVE (+)-NEGATIVE (–): Positive (+)

AUTO-NORMAL: Normal

AC-GND-DC: GND

VOLTS/CM: 0.05

VARIABLE: CAL (full clockwise).

VERT POS: Center of rotation

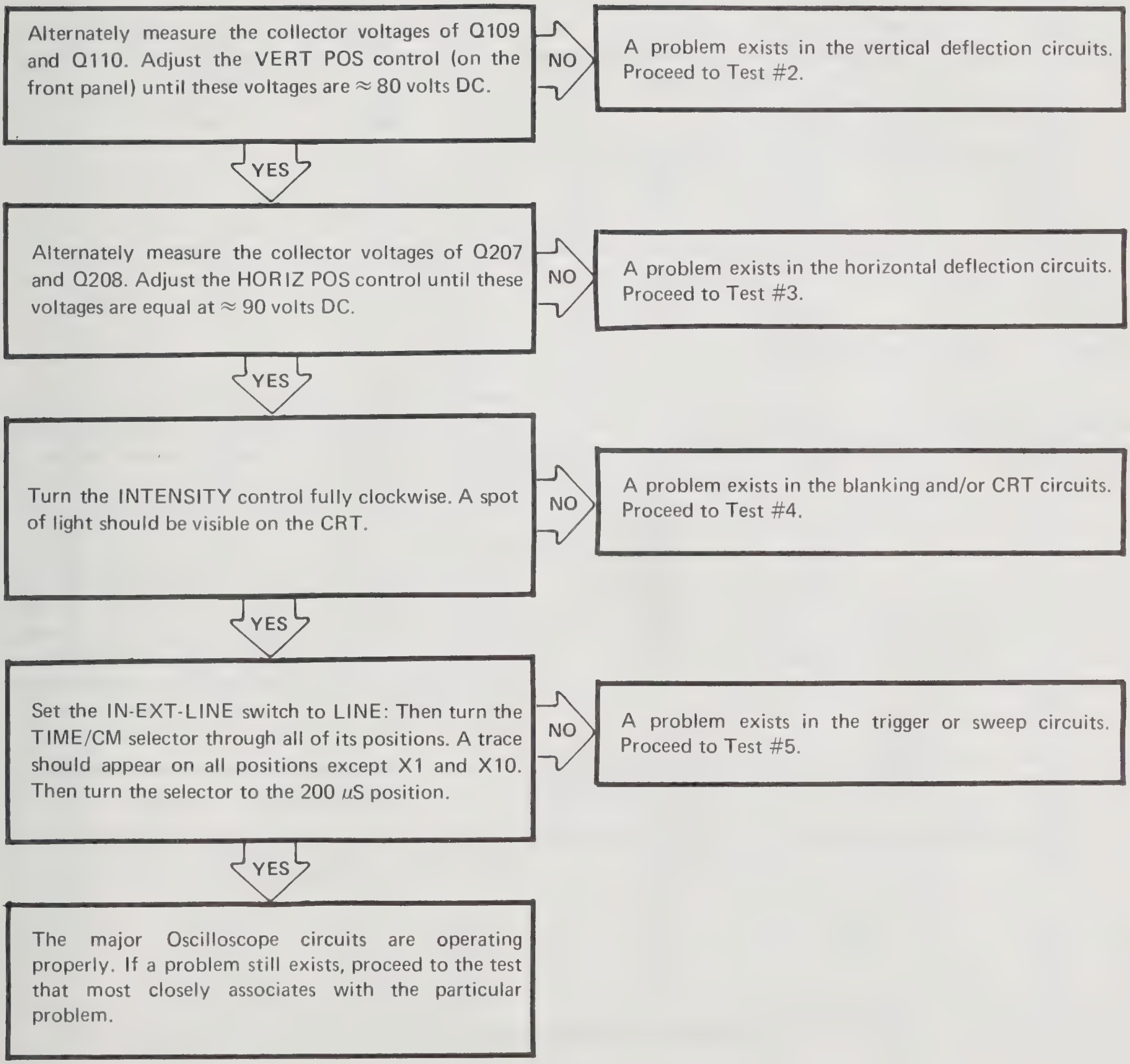
OFF-ON: OFF

Do not change the position of any control or switch unless you are instructed in a step to do so.

Connect the line cord to an AC outlet and turn the Oscilloscope on.

Perform the ±9 and +5 volt power supply test (Test #1) in the Illustration Booklet to verify the operation of the power supplies before you proceed. These power supplies must operate properly before you attempt any further troubleshooting. After you have completed Tests #1, proceed to the "Trouble Locator Chart."

TROUBLE LOCATOR CHART



Alternately measure the collector voltages of Q109 and Q110. Adjust the VERT POS control (on the front panel) until these voltages are ≈ 80 volts DC.

A problem exists in the vertical deflection circuits. Proceed to Test #2.

Alternately measure the collector voltages of Q207 and Q208. Adjust the HORIZ POS control until these voltages are equal at ≈ 90 volts DC.

A problem exists in the horizontal deflection circuits. Proceed to Test #3.

Turn the INTENSITY control fully clockwise. A spot of light should be visible on the CRT.

A problem exists in the blanking and/or CRT circuits. Proceed to Test #4.

Set the IN-EXT-LINE switch to LINE: Then turn the TIME/CM selector through all of its positions. A trace should appear on all positions except X1 and X10. Then turn the selector to the 200 μS position.

A problem exists in the trigger or sweep circuits. Proceed to Test #5.

The major Oscilloscope circuits are operating properly. If a problem still exists, proceed to the test that most closely associates with the particular problem.

CHECKING COMPONENTS

INTRODUCTION

To check a transistor accurately, you should use a transistor checker. However, if one is not available, you can use an ohmmeter to determine the general condition of any of the bipolar transistors (or diodes) in this kit. The ohmmeter used must have at least 1 volt DC at the probe tip to exceed the threshold of the diode junctions in the transistor being tested.

Set your ohmmeter to its low range for the following tests.

HOW TO CHECK TRANSISTORS AND DIODES

A. Unsolder and remove the component.

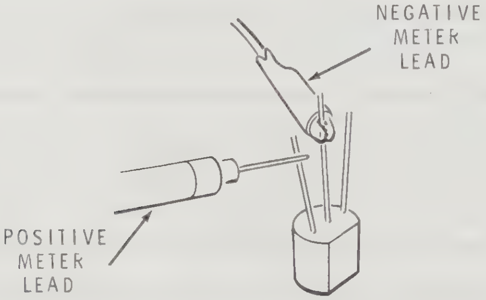
B. Connect the ohmmeter leads to the component as shown in the example illustration for transistors and diodes.

Example:

TRANSISTORS

Connect the positive meter lead to one lead as directed in the chart.

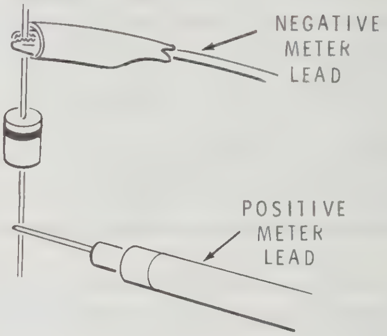
Connect the negative meter lead to another lead, as directed in the chart.



DIODES

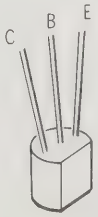
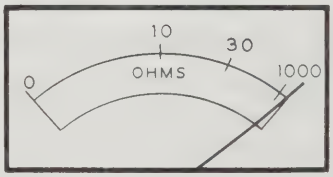
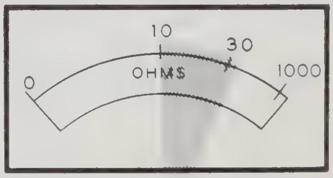
Connect the negative meter lead to one lead as directed in the chart.

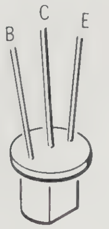
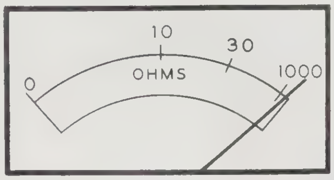
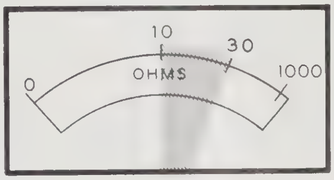
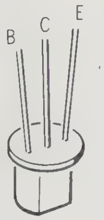
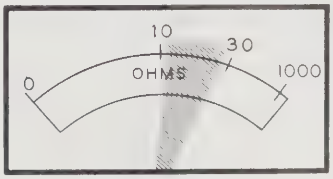
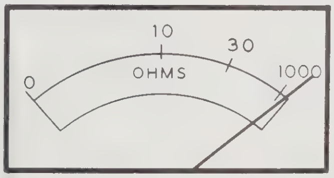
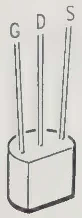
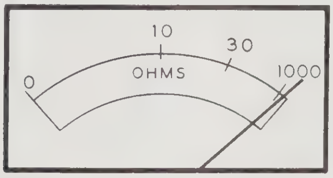
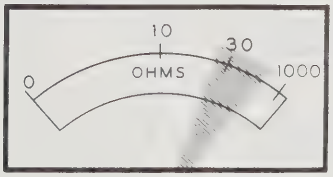
Connect the positive meter lead to the other lead, as directed in the chart.

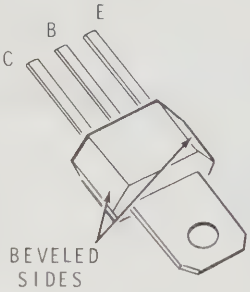
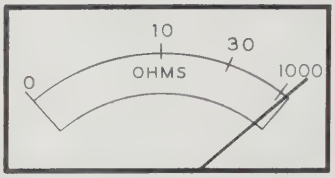
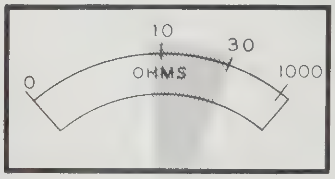
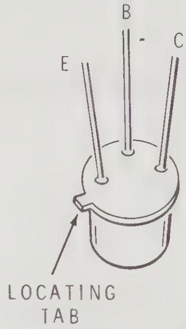
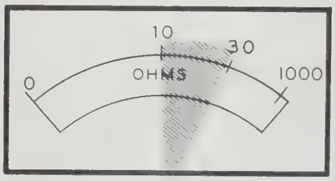
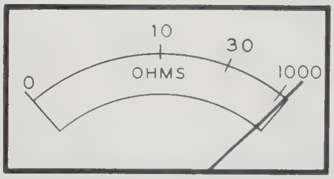
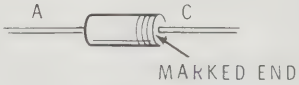
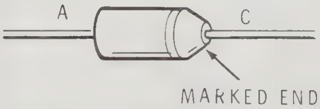
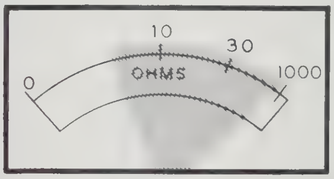
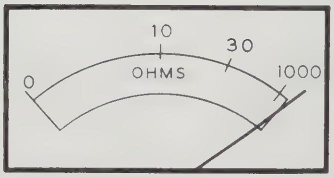


Proceed to the following chart and connect the ohmmeter leads to the component as indicated in the columns titled "Connect Positive Lead To," and "Connect Negative Lead To." The indicated meter reading in the last column is only a nominal reading. Your meter may read slightly different.

NOTE: The polarity of all ohmmeters is not the same. Therefore, if you do not get the indicated results, reverse your meter leads and try again. If you do get the correct results now, cross out the word "negative" in the heading in the second column and write in "positive." Also cross out the word "positive" in the heading in the third column and write in "negative."

TRANSISTOR	CONNECT NEGATIVE LEAD TO:	CONNECT POSITIVE LEAD TO:	METER READING
MPSA20 (417-801) 	B B E	C E C	
	C E	B B	

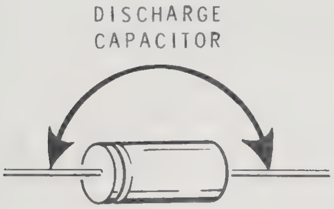
TRANSISTOR	CONNECT NEGATIVE LEAD TO:	CONNECT POSITIVE LEAD TO:	METER READING
X29A829 (417-201) 	C E C	B B E	
	B B	E C	
L842 (417-83) 	C E	B B	
	B B C	E C E	
NOTE: YOU MAY HAVE TO SET YOUR OHMMETER TO A HIGHER RANGE TO MEASURE THIS TRANSISTOR EL131 (417-241) 	G G D S	D S G G	
	D S	S D	

TRANSISTOR	CONNECT NEGATIVE LEAD TO:	CONNECT POSITIVE LEAD TO:	METER READING
MPSU10 (417-834)  	B B E	E C C	
	C E	B B	
2N2369 (417-154)  	C E C	B B E	
	B B	E C	
DIODES 56-26, 56-56, 56-19, 56-16, 56-68, 56-97, 57-27   	C	A	
	A	C	

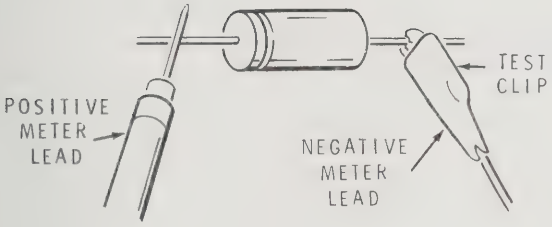
HOW TO CHECK CAPACITORS

A. Unsolder and remove the capacitor.

B. Discharge the capacitor by touching the leads together.



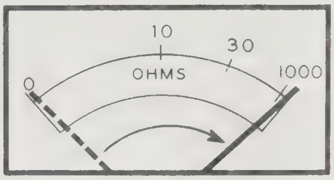
C. Connect the negative meter lead to one lead. Then, while watching the meter, touch the positive meter lead to the other capacitor lead. (Note the special instructions for the electrolytic capacitors.)



How to Connect Electrolytic Capacitors to the Meter and Chassis

Each electrolytic capacitor has a positive (+) mark at one end. When checking one of these capacitors, connect the positive (+) lead to the positive meter lead and the other lead to the negative lead.

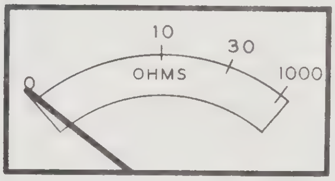
1. If the meter pointer deflects to the low ohms side quickly, and then gradually returns to the high ohms side, the capacitor is not faulty. NOTE: The time it takes for the pointer to return to the high ohms side depends upon the value of the capacitor. A 50 μF capacitor for example, will cause the pointer to return more rapidly than a 500 μF capacitor.



CAPACITOR OK
#4

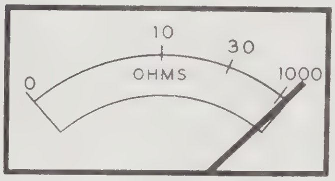
2. If the meter pointer deflects to the low ohms side and stays there, the capacitor is faulty (shorted).

CAPACITOR FAULTY (Short)



3. If the meter pointer does not deflect at all, but stays at the high ohms side, the capacitor is faulty (open).

CAPACITOR FAULTY (Open)



4. Recheck the capacitor, BUT FIRST DISCHARGE IT BY TOUCHING THE LEADS TOGETHER.

Because of the small capacitance of capacitors below the value of 50 μF, it is very difficult to determine if the capacitor is faulty (open). If your meter needle does not move at all when you are checking a small value capacitor, it does not mean that the capacitor is open.

SPECIFICATIONS

VERTICAL

Bandwidth	DC to 5 MHz, ±3 dB.
Attenuator	1, 2, 5 sequence, calibrated and variable.
Rise Time	70 ns.
Overshoot	5% at 1 kHz.
Impedance	1 MΩ/38 pF.
Sensitivity	20 mv/cm.

SWEEP

Type	Triggered.
Range	200 ms to .2 μs in 7 steps, plus variable.
Trigger Source	Int/Ext/Line.
Trigger Modes	AC/DC/TV; +/- Slope; Auto/Norm.

HORIZONTAL

Sensitivity	.25 V/cm.
Bandwidth	DC to 100 kHz.
Impedance	1 MΩ/50 pF.
Ext Horiz Input	X1 and X10 attenuator and variable.

GENERAL

CRT	5DEP31F. 8 x 10 centimeter viewing area. Blue-green, medium-persistence phosphor. 5" round, flat face tube.

Accelerating Potential	Approximately 1.5 kV.
Graticule	Screened, 8 x 10 centimeters.
Power requirements	110-130 VAC or 220-260 VAC, 50/60 Hz, 35 watts.
Overall Dimensions	13" wide, 8" high, 17" deep.
Net Weight	14 lbs.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram and the Block Diagram in the Illustration Booklet while you read the following circuit description.

To help you locate specific parts in the Oscilloscope or on the Schematic, the resistors, capacitors, transistors, and diodes are numbered in the following groupes:

1- 99	Parts on the chassis.
101-199	Parts on the vertical amplifier circuit board.
201-299	Parts on the horizontal amplifier circuit board.
301-399	Parts on the sweep-trigger circuit board.
401-499	Parts on the power supply circuit board.

VERTICAL AMPLIFIER

A signal applied to the vertical Input connector on the front panel of the Oscilloscope is coupled through the frequency-compensated attenuator network. Capacitor CI blocks the DC when switch SW1 is in the AC position. From the attenuator circuit, a portion of the input signal is coupled through resistor R101 and capacitor C101 to the gate of transistor Q101. Diodes ZD101 and ZD102 are transistors connected to provide a zener action. Resistor Q101 and these diodes limit the input signal to approximately ±9 volts, which protects Q101 from excessively high gate voltage. Capacitor C101 improves high frequency response by forming a high frequency path around R101.

Transistor Q101 is a field-effect transistor (FET) which is connected as a source follower. This type of transistor provides the high impedance input necessary to prevent loading of the attenuator.

Transistor Q102 is a constant current source for input transistor Q101. Since the base voltage of transistor Q102 is held constant by divider R105, R106, and the emitter voltage is dependent upon the base voltage, the emitter voltage will remain constant. This constant emitter voltage is across emitter resistor R103; therefore, the current through R103 is constant. Resistor R103 is adjusted so the source voltage of Q101 is zero when an input signal is not present.

A signal applied to the gate of Q101 will cause only voltage changes at the source because the current through Q101 is constant. These voltage variations are applied across resistors R102, R4, R5, R6, R7, and a portion of this signal is applied to the gate of source follower Q103.

Transistor Q104 forms a constant current source for transistors Q105 and Q106. Since the emitters of both transistors are connected to this constant current source, the current source serves as a common emitter resistance and sets the operating point for the following steps.

The output from source follower transistor Q103 is amplified by transistor Q105. A portion of the signal applied to the base of Q105 appears at its emitter. Because transistors Q105 and Q106 have a common emitter resistance, the signal present at the emitter of transistor Q105 is effectively coupled to the emitter of transistor Q106.

Transistor Q106 operates as a common base amplifier whose base is held constant by Vertical Position control R8. This control positions the trace by applying a controllable DC voltage to the base of transistor Q106, thus providing a controllable DC balance in the vertical amplifier. When the collector output voltage of Q105 decreases, its emitter voltage will increase. An increased emitter voltage at Q106 reduces its forward bias and increases its collector output voltage. The signal at the collector of transistor Q106 is 180 degrees out of phase with the signal at the collector of transistor Q105, forming a "push-pull" amplifier to drive the CRT deflection plates. Capacitor C104 is an emitter bypass capacitor to boost the gain at high frequencies.

Driver transistors Q107 and Q108 are common emitter amplifiers. In addition to providing gain, they also isolate transistors Q105 and Q106 from the output stages. Capacitor C105 AC bypasses the emitter resistors of Q107 and Q108 at high frequencies and improves the high frequency response. Output amplifiers Q109 and Q110 again amplify the differential signal and drive the vertical plates in the CRT. Transistor Q111 operates as an emitter follower and provides the trigger signal to the sweep circuit.

HORIZONTAL AMPLIFIER

Operation of the horizontal amplifier is similar to that of the vertical amplifier. The major difference is that the horizontal amplifier does not have a PNP amplifier stage (transistors Q107 and Q108 in the vertical amplifier).

The positive-going ramp voltage (sawtooth) from the sweep generator is amplified and applied to the horizontal plates of the CRT. This increasing voltage causes the electron beam to sweep across the face of the CRT, producing a visible trace.

SWEEP-TRIGGER CIRCUITS

Switch SW3 selects the source of the trigger signal (internal, external, or line) and couples this signal to switch SW4. Switch SW4 selects the type of coupling (AC, DC, or TV) that will be used to couple the signal to the triggering circuits. In the AC position, the signal is coupled through capacitor C6 to the triggering circuits. In the DC position the signal is coupled direct, and in the TV position the signal is coupled through capacitor C6, C7, resistor R12, and diode D1. The circuit composed of capacitor C7, resistor R12, and diode D1 forms a low-pass filter and DC restorer. This circuit allows the triggering circuits to be synchronized to the vertical frame rate of a complex video TV signal.

The triggering signal is coupled through resistor R302 to the gate (G) of transistor Q301. Resistor R301 determines the input resistance to Q301. ZD301 and ZD302 are transistors connected to provide a zener action. This diode configuration protects the input of Q301 by preventing the triggering signal from going greater than ±9 volts.

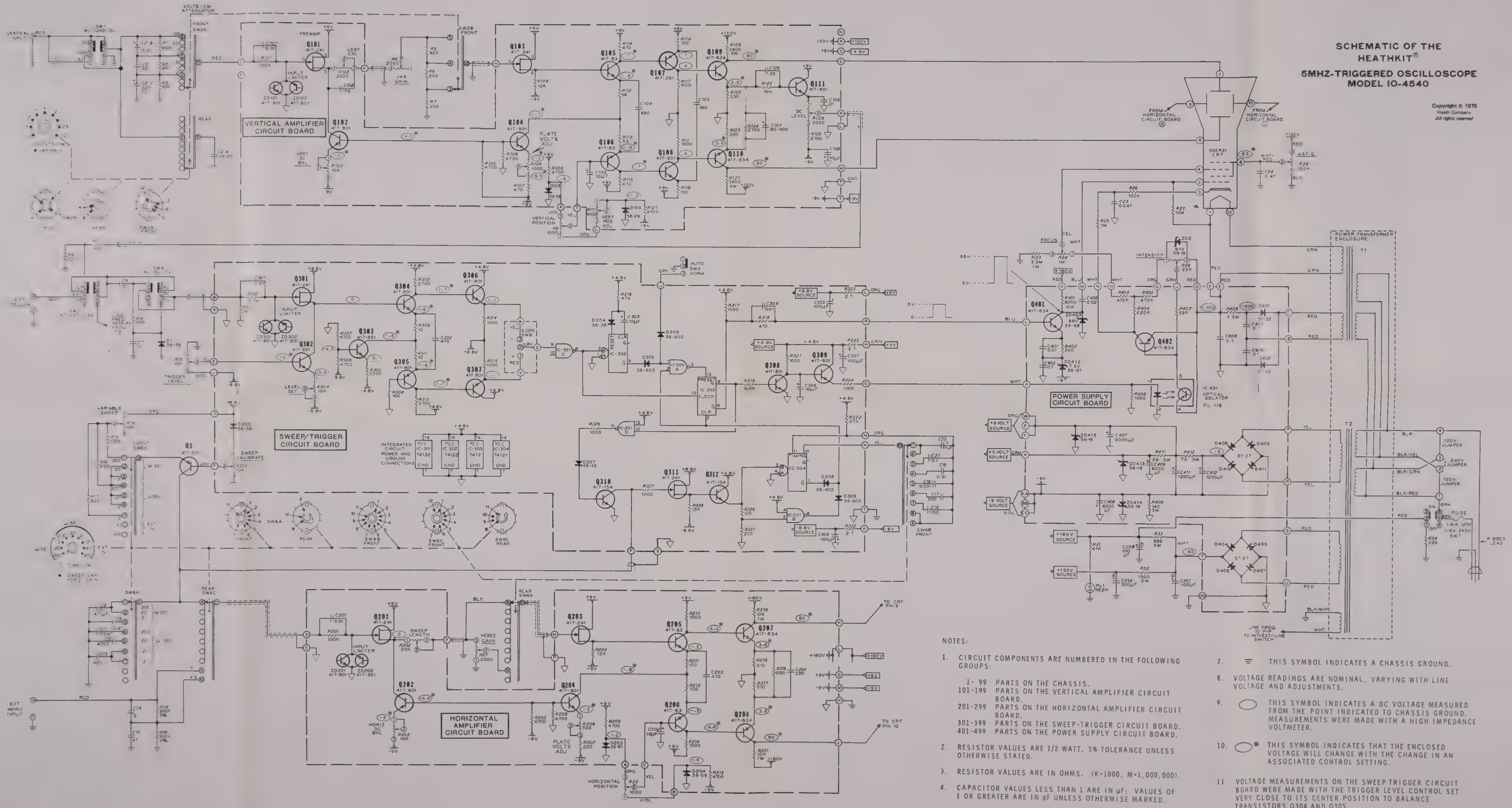
From transistor Q301, the signal is applied to differential amplifier transistors Q304 and Q305. From here the amplified signal is coupled through transistors Q306 and Q307 to slope switch SW8. This switch selects either the positive (+) or negative (–) slope of the waveform.

Transistor Q302 is the current source for Q301, and Q303 is the current source for Q304, and Q305. The trigger level control sets the amount of current that is allowed to flow through transistor Q302, which varies the DC level at the source (S) of transistor Q301. This change is coupled to and affects transistors Q304 and Q305 and, in turn, is coupled to transistors Q306 and Q307, which vary the voltage on lugs 1 and 3 of switch SW8.

The amplified signal (either positive or negative slope as is selected by switch SW8) is coupled to pin 9 of IC301C. IC301A, IC301B, IC301C, and IC301D are Schmitt input gates. That is to say, that at a specific positive level of the input signal the gate switches on, and at a specific level as the signal decreases the gate switches off. This switching on and off produces a pulse at the output of the gate.

As the signal is coupled to pin 9 of IC301C, it switches, and a negative pulse is produced at pin 8. This is coupled to pin 12 of IC303, causing IC303 to switch and produce a negative pulse at pin 8 and a positive pulse at pin 6. The pulse from pin 6 is coupled through resistor R318 to AC blanking transistor Q401, while the pulse from pin 8 is coupled through resistor R319 to DC blanking transistor Q308 and also to pin 12 of IC301D.

Two CRT blanking circuits (one AC coupled and one DC coupled) are employed in this Oscilloscope. The DC blanking circuit is more efficient at lower sweep frequencies. At higher sweep frequencies, the AC blanking is more efficient. In the following paragraphs both types of blanking will be discussed.



SCHEMATIC OF THE HEATHKIT®

5MHZ-TRIGGERED OSCILLOSCOPE MODEL IO-4540

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NOTES:

1. CIRCUIT COMPONENTS ARE NUMBERED IN THE FOLLOWING GROUPS:

1- 99	PARTS ON THE CHASSIS.
101-199	PARTS ON THE VERTICAL AMPLIFIER CIRCUIT BOARD.
201-299	PARTS ON THE HORIZONTAL AMPLIFIER CIRCUIT BOARD.
301-399	PARTS ON THE SWEEP-TRIGGER CIRCUIT BOARD.
401-499	PARTS ON THE POWER SUPPLY CIRCUIT BOARD.

2. RESISTOR VALUES ARE 1/2 WATT, 5% TOLERANCE UNLESS OTHERWISE STATED.

3. RESISTOR VALUES ARE IN OHMS. (K=1000, M=1,000,000).

4. CAPACITOR VALUES LESS THAN 1 ARE IN µF: VALUES OF 1 OR GREATER ARE IN pF UNLESS OTHERWISE MARKED.

5. ☐ THIS SYMBOL WITH A LETTER IN IT INDICATES A WIRE CONNECTION TO A CIRCUIT BOARD.

6. ▽ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.

7. ≡ THIS SYMBOL INDICATES A CHASSIS GROUND.

8. VOLTAGE READINGS ARE NOMINAL, VARYING WITH LINE VOLTAGE AND ADJUSTMENTS.

9. ○ THIS SYMBOL INDICATES A DC VOLTAGE MEASURED FROM THE POINT INDICATED TO CHASSIS GROUND. MEASUREMENTS WERE MADE WITH A HIGH IMPEDANCE VOLTMETER.

10. ○* THIS SYMBOL INDICATES THAT THE ENCLOSED VOLTAGE WILL CHANGE WITH THE CHANGE IN AN ASSOCIATED CONTROL SETTING.

11. VOLTAGE MEASUREMENTS ON THE SWEEP TRIGGER CIRCUIT BOARD WERE MADE WITH THE TRIGGER LEVEL CONTROL SET VERY CLOSE TO ITS CENTER POSITION TO BALANCE TRANSISTORS Q304 AND Q305.

12. VOLTAGES ON THE BASES OF TRANSISTORS Q106 AND Q206 WILL BE EQUAL TO THE GATE TO SOURCE VOLTAGE OF TRANSISTORS Q103 AND Q203 RESPECTIVELY.

SCHEMATIC OF THE
HEATHKIT®
5MHZ-TRIGGERED OSCILLOSCOPE
MODEL IO-4540

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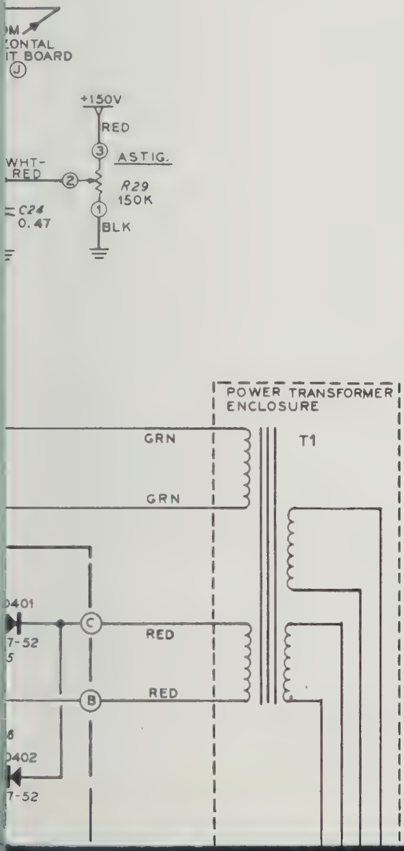


BLANKING

It is desirable to turn off the CRT during periods of "no signal" and also between successive sweeps so that the retrace lines is not visible. The CRT can be turned off (blanked) or on (unblanked) by a controlling voltage between the cathode and grid in the CRT. As the grid voltage becomes more positive with respect to the cathode, the trace will become brighter. The CRT is completely cut off when a sufficiently negative voltage is applied to the grid.

This Oscilloscope uses two blanking schemes: AC coupling to the grid, and DC coupling to the cathode of the CRT. The AC coupled system is operational all of the time; while the DC system is held off for frequencies over 60 Hz, due to the long on-off time of the device by capacitor C306 and R321. For frequencies less than 60 Hz, the AC system is unable to keep the tube blanked for long periods of time. The DC system is then used to keep the CRT blanked for the longer period of time.

Assume that the sweep generator is sweeping normally across the CRT. At this time, pin 8 of IC303 is high and pin 6 is low. (A low constitutes 0.5 volts or less and a high constitutes 2.5 volts or more.) With this condition, the AC and DC blanking systems are turned off. When the sweep voltage reaches a predetermined level, IC304 will change state and this causes IC303 to change state.

When IC303 changes state, pin 6 goes high which turns on transistor Q401 and causes a negative voltage at the grid of the CRT, thus blanking it. At the same time pin 8 goes low, which turns on transistor Q310 and shorts the sweep generator voltage back to zero volts. Transistor Q308 also turns on at this time, which turns on the optical isolator (IC-401). The optical isolator turns off transistor Q402, which causes the cathode of the CRT to go more positive again, blanking the CRT.

The blanking and sweep circuits stay in this state until a trigger pulse is applied to IC303 and causes it to change state, and the sequence repeats itself again.

RAMP GENERATOR

The negative pulse that is produced at pin 8 of IC303 is also coupled to pin 12 of IC301D. Here the pulse is inverted and coupled from pin 11, through resistor R326 and diode D307, to transistor Q310, biasing it off. Normally, transistor Q310 is conducting, which keeps the output from the ramp generator connected to ground.

The ramp generator is composed of transistor Q1, resistors R15, R16, and R17, and capacitors C8, C9, C11, C12, and C13. Transistor Q1 provides constant current to the timing resistors and capacitors which are selected by section A and C of switch SW6. When transistor Q310 is biased off, the selected timing capacitor (for example, we will use C8) begins to charge. This causes an increase or "ramp" of voltage that is coupled through resistor R327 to the gate of transistor Q311.

The ramp voltage is coupled through transistors Q311 and Q312 to pin 5 of IC304. Q311 and Q312 provide isolation to the ramp generator. When the ramp voltage increases to 1.2 volts, pin 1 of IC304 produces a pulse, which is coupled through diode D308 to pin 2 of IC303. This cancels the pulse on pins 6 and 8 of IC303 and allows the CRT to become blanked again.

With the pulse gone from pin 8 of IC303, transistor Q310 begins to conduct and the charge on capacitor C8 rapidly decays to zero. Thus, a sawtooth waveform has been formed by the charging of capacitor C8 and its rapid discharge. This sawtooth voltage is coupled through section B of switch SW6 to the horizontal amplifier circuit board.

IC301B is an anti-latch-up circuit. It is possible for a random pulse to be generated somewhere in the sweep circuits and cause IC303 or IC304 to miss their triggering pulse from IC302. If this should happen, the ramp voltage will increase until it reaches approximately 2 volts. This voltage is coupled through resistor R329 to pin 5 of IC301B. This causes a pulse to be produced at pin 6 of IC301B which is coupled through diode D309 to pin 2 of IC303, and IC303 reacts normally, as though it received the pulse from IC304.

POWER SUPPLY

Line voltage is connected through the fuse and the On-Off switch to the primary windings of power transformers T1 and T2. The dual primary windings of these transformers may be connected in parallel for 120 volt operation or in series for 240 volt operation. 240 volt operation is common outside the U.S.A.

The secondary windings of transformer T1 are connected to the voltage doubler circuit consisting of diodes D401, D402, and capacitors C405 and C406. Capacitor C404 filters this negative high voltage which is fed through resistor R26 to the grid of the CRT. The intensity and focusing voltages are also supplied to the CRT from the voltage divider network consisting of resistors R28, R405, R403, R23, and R24. A separate 6.3 volt winding supplies the CRT filament voltage.

Optimum focus is obtained when the CRT deflection plates and the astigmatism grid are at the same potential. Since the vertical deflection plate voltages (collectors of Q109 and Q110) are adjusted to 85 volts DC by constant-current source Q104, the astigmatism voltage is also adjusted to approximately 85 volts DC.

The secondary windings of low voltage transformer T2 are connected to the full-wave bridge rectifier circuit which consists of diodes D408, D409, D410, and D411. Capacitor C412 filters the rectified DC. This DC voltage is regulated by zener diodes ZD413, ZD414, and ZD415. By connecting equal loads from each side of the supply to ground, separate supplies are obtained: These separate supplies are, +9 volts DC, –9 volts DC, and 5 volts DC.

Another secondary winding of transformer T2 is connected to another full-wave rectifier circuit which consists of diodes D404, D405, D406, and D407. Capacitor C25 filters the rectified DC voltage. A voltage divider circuit composed of resistors R32 and R33 provide 180 and 150 volt DC supplies.

A third secondary winding on transformer T2 supplies 1 volt peak-to-peak AC voltage to the front panel output jack.

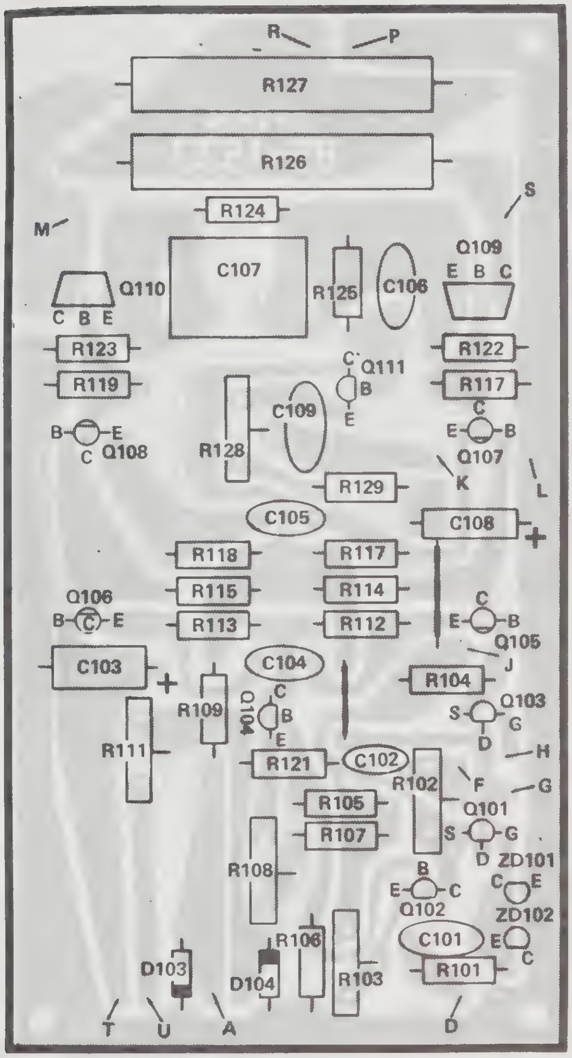
CIRCUIT BOARD X-RAY VIEWS

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

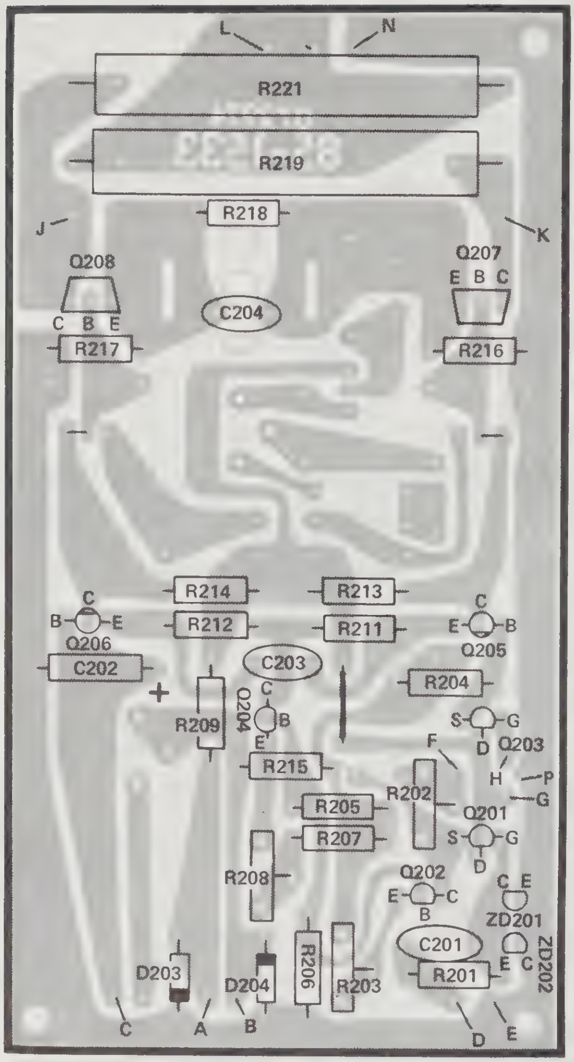
A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View."

B. Locate this same number in the "Circuit Component Number" column of the proper "Parts List."

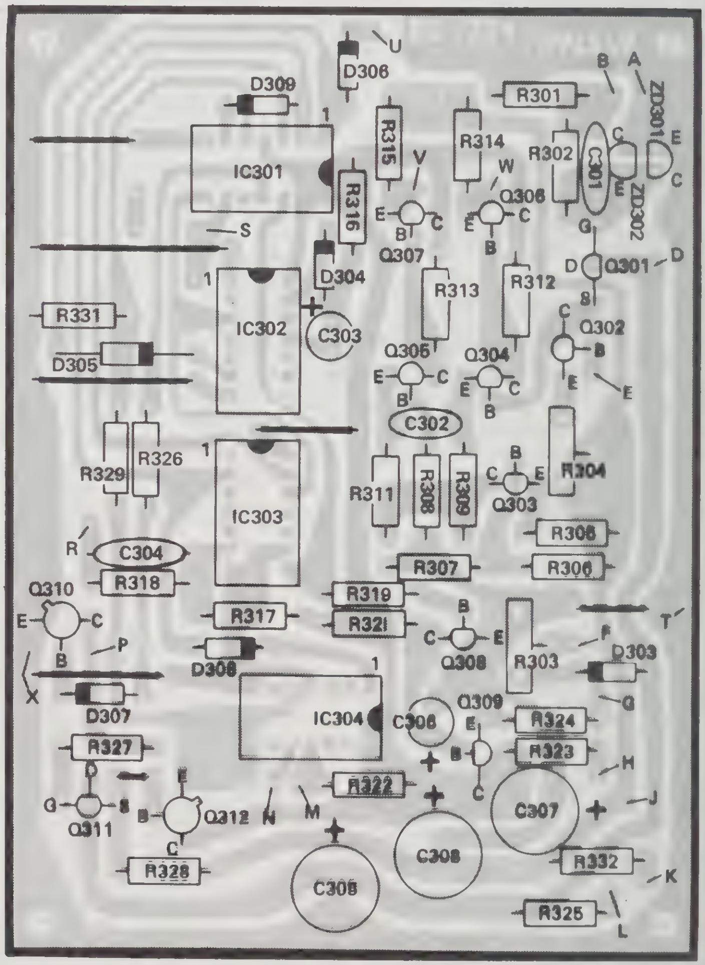
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



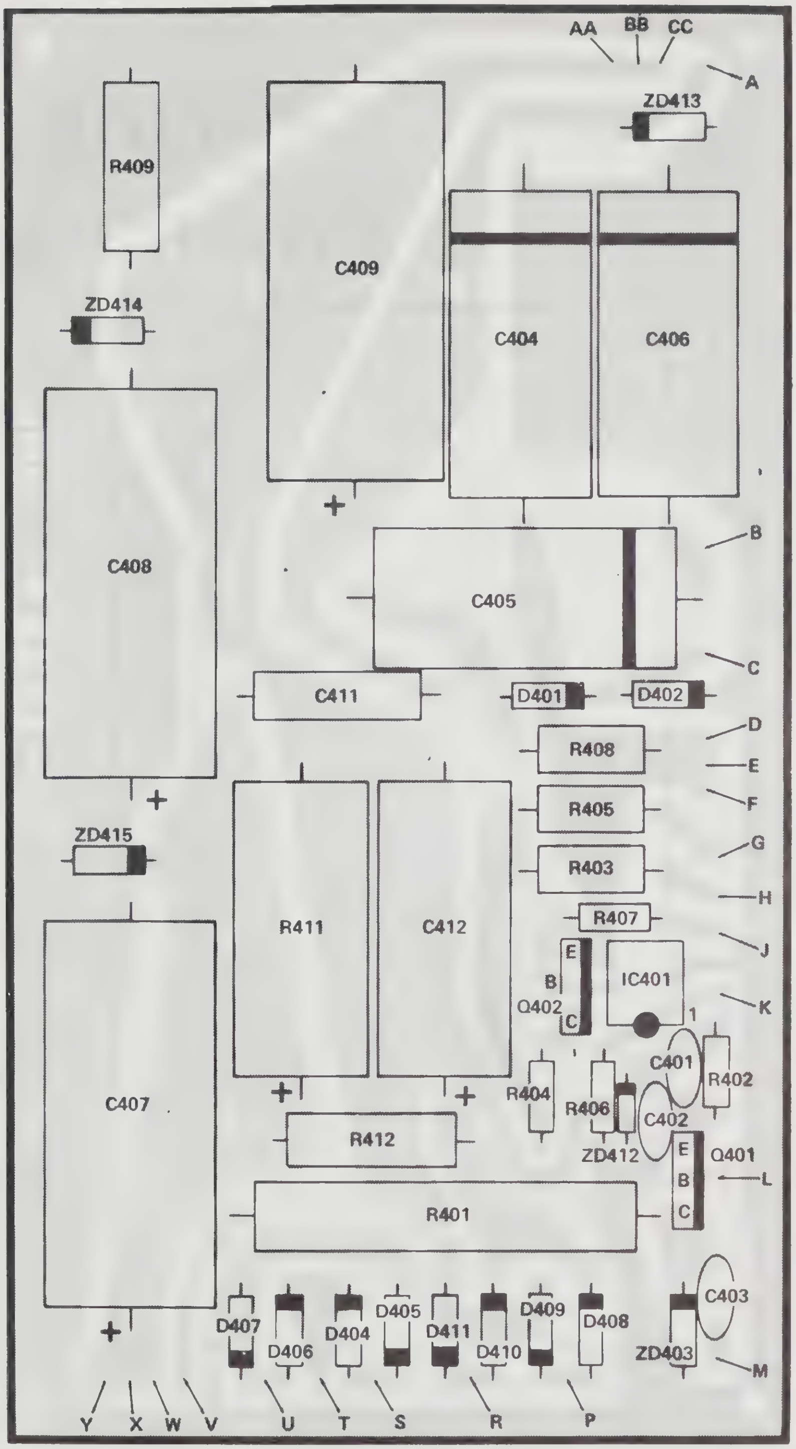
VERTICAL AMPLIFIER CIRCUIT BOARD
(Viewed from component side)



HORIZONTAL AMPLIFIER CIRCUIT BOARD
(Viewed from component side)

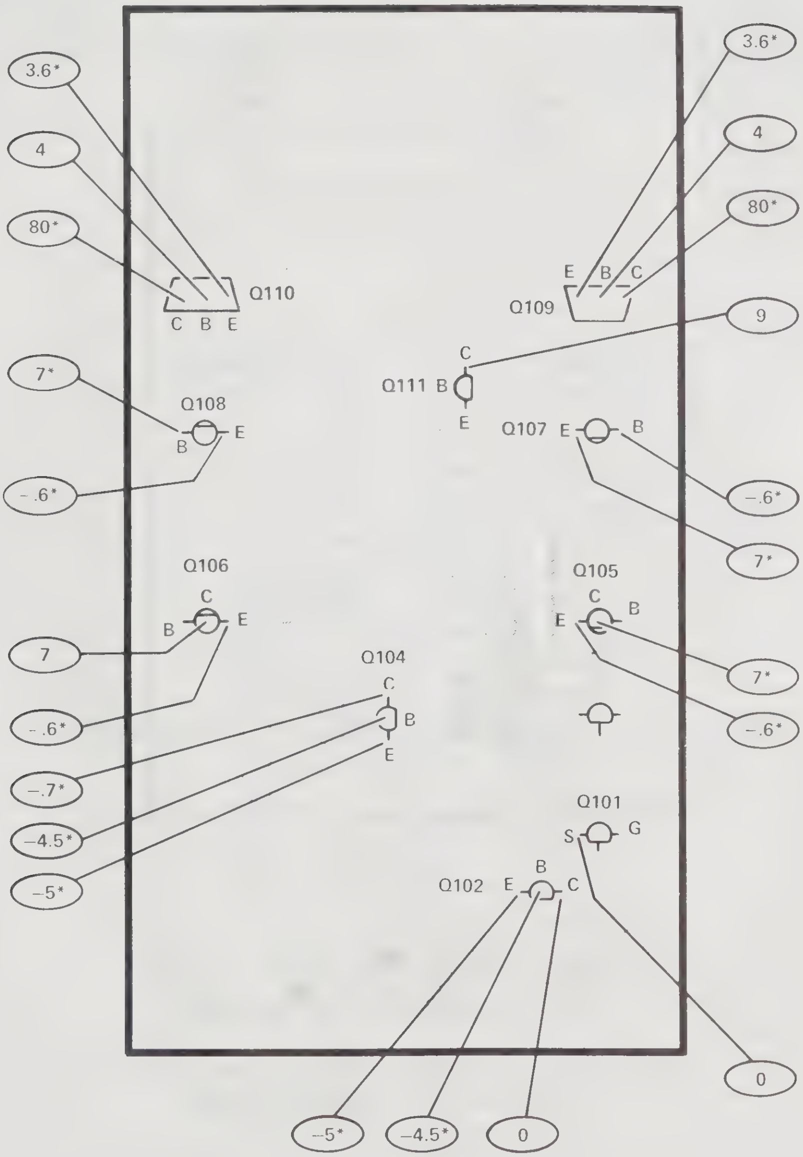


SWEEP TRIGGER CIRCUIT BOARD
(Viewed from component side)



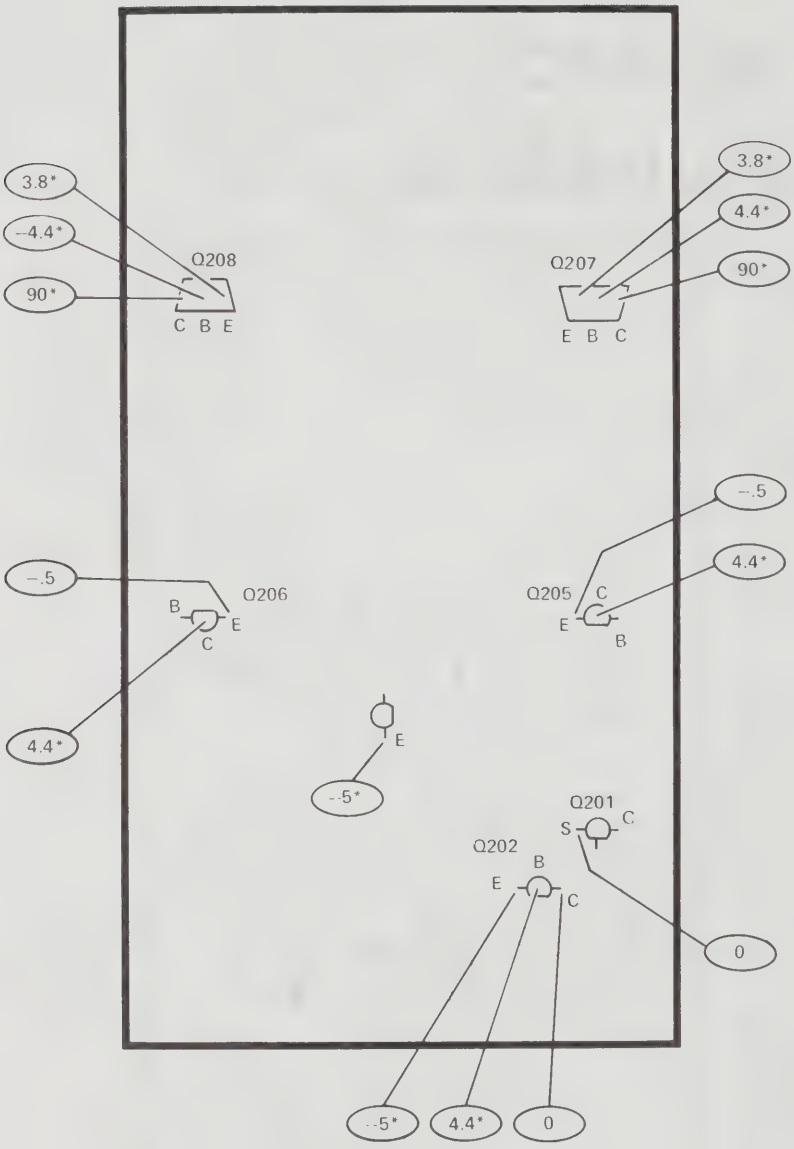
POWER SUPPLY CIRCUIT BOARD
(Viewed from component side)

CIRCUIT BOARD VOLTAGE CHARTS



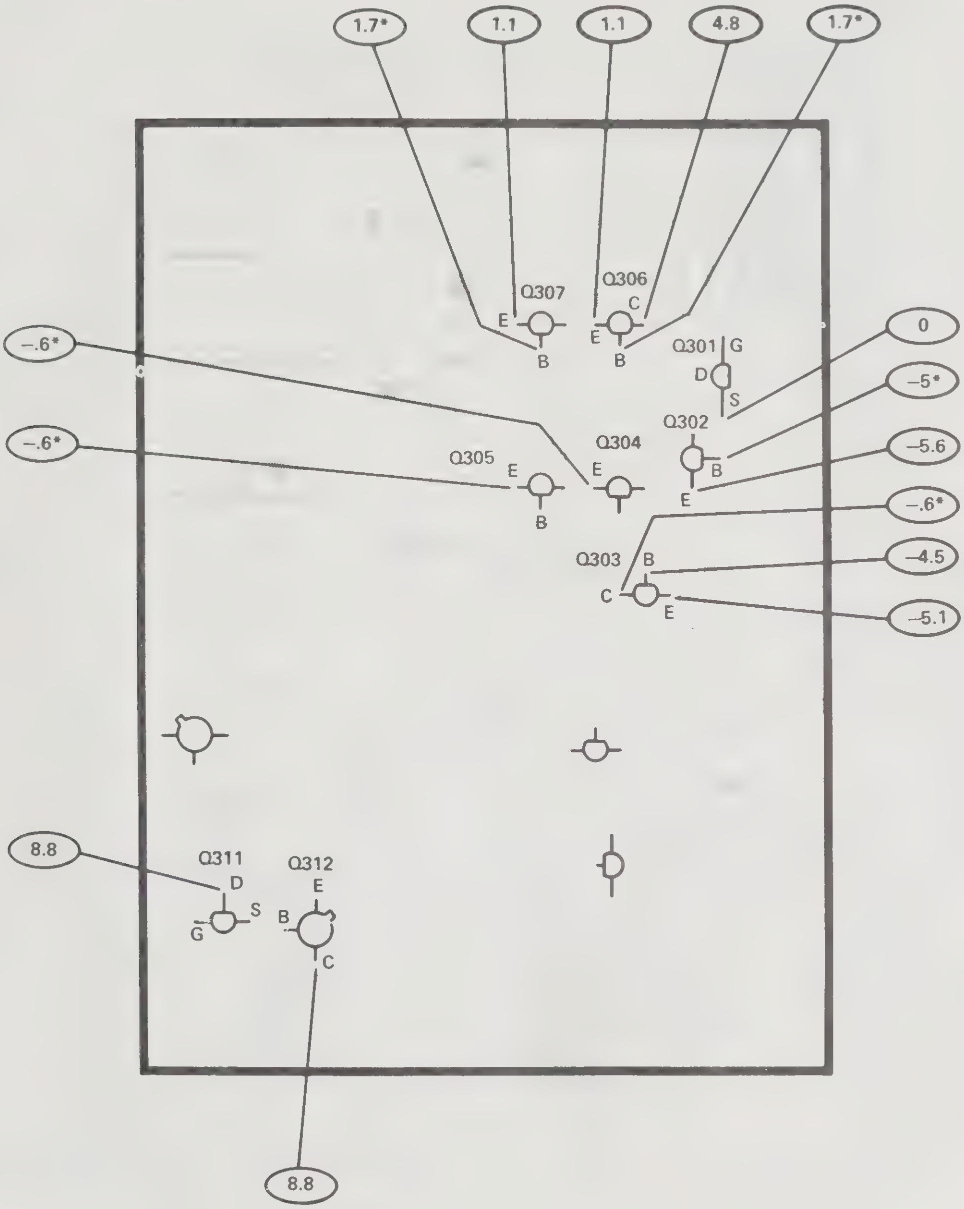
VERTICAL AMPLIFIER CIRCUIT BOARD
(Viewed from component side)

*Indicates a voltage that will change with an associated control setting change.



HORIZONTAL AMPLIFIER CIRCUIT BOARD
(Viewed from component side)

*Indicates a voltage that will change with an associated control setting change.



SWEEP-TRIGGER CIRCUIT BOARD
(Viewed from component side)

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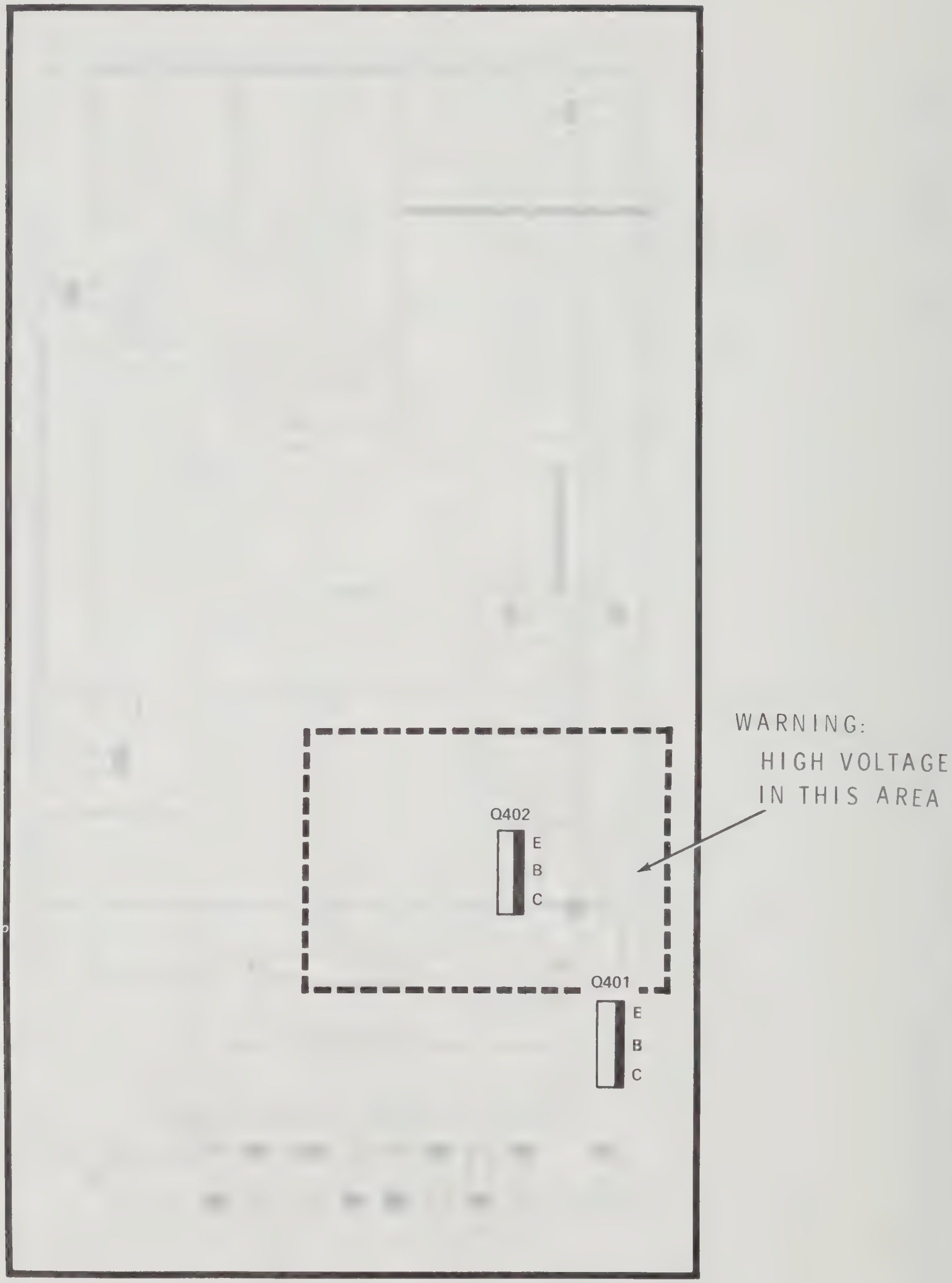
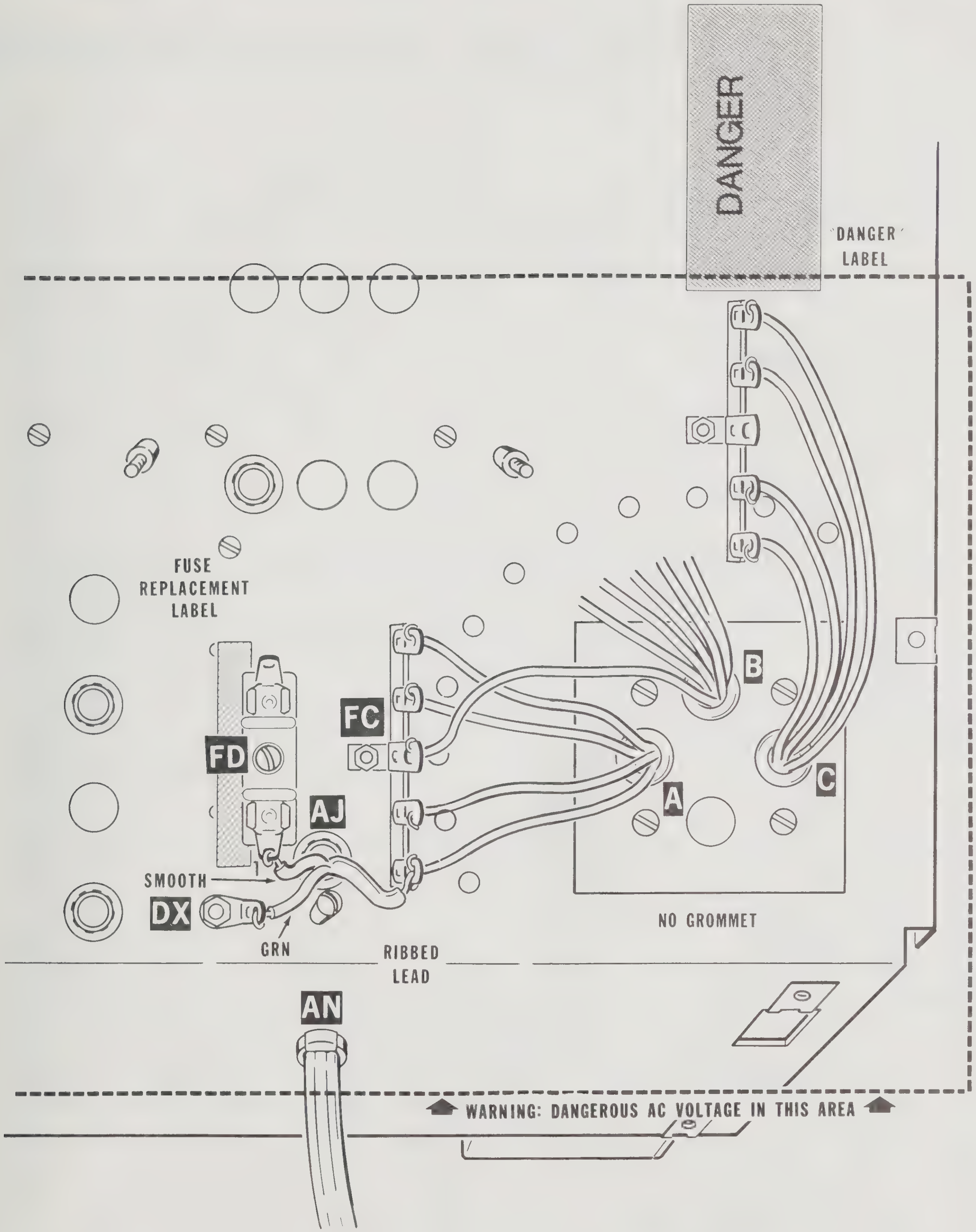
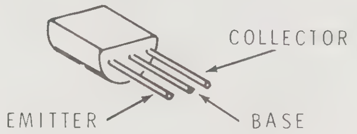
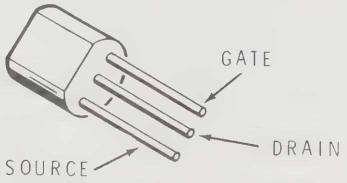
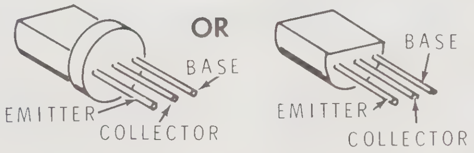
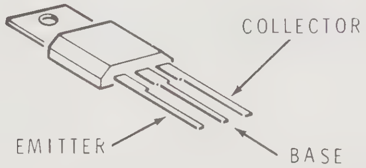
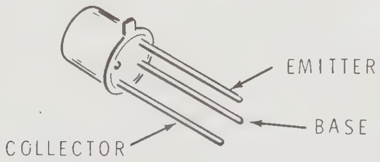
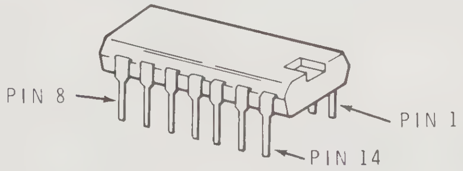
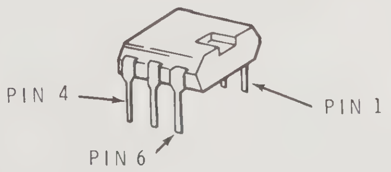
*Indicates a voltage that will change with an associated control setting change.



POWER SUPPLY CIRCUIT BOARD
(Viewed from component side)


DANGER
'DANGER' LABEL
FUSE REPLACEMENT LABEL
FD
FC
AJ
SMOOTH
DX
GRN
RIBBED LEAD
B
A
C
NO GROMMET
AN
WARNING: DANGEROUS AC VOLTAGE IN THIS AREA

IDENTIFICATION CHART

CIRCUIT DESIGNATION	PART NUMBER	MANUFACTURE TYPE NUMBER	LEAD IDENTIFICATION
ZD101, ZD102, Q101, Q104, Q111, ZD201, ZD202, Q201, Q204, Q302, Q303, Q304, Q305, Q306, Q307, Q308, Q309, ZD301, ZD302.	417-801	MPSA20	
Q101, Q103, Q201, Q203, Q301, Q311.	417-241	EL131	
Q105, Q106, Q205, Q206.	417-83	L842	 OR BASE EMITTER COLLECTOR BASE EMITTER COLLECTOR
Q107, Q108, Q1.	417-201	X29A829	
Q109, Q110, Q209, Q210, Q401, Q402.	417-834	MPSU10	
Q310, Q312.	417-154	2N2369	
IC304	443-22	SN74121	
IC301	443-625	SN74132	
IC302	443-23	SN74122	
IC303	443-4	SN7472	
IC401 .	443-631	TIL115	

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QTY.	HEATH PART NUMBER	DESCRIPTION OF PART	PRICE	TOTAL PRICE

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QTY.	HEATH PART NUMBER	DESCRIPTION OF PART	PRICE	TOTAL PRICE

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